
TIPS, TRICKS AND TECHNIQUES OF
THE USER GROUP MASTERS
OF THE ZX-81/TS1000 COMPUTER

Early, Beta
Version 0.33

For Review Only

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by Bill J. Harmer, Ottawa, Canada

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TSAK:

The writer would like to acknowledge all the user group members who have helped add to his expertise, such as it is, and especially the late Donald Lamen, whose articles on the ULA have proven indispensable shortcuts to understanding the ZX-81 internals. Thanks to those of the Dallas/Ft.Worth Usr.Gp. who originally suggested public domain publishing and challenged us all.

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ZX-81/TS1000 Tips, Tricks And Techniques From The User Group Masters

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FORWARD

At this late date into the 1990's no less, it would seem long past the time to compile a list of tips and tricks and application notes on the Sinclair ZX-81/TS1000 home computer. However, there is method in this madness. The computers are still being used both by diehard old hands and new recipients through loan or gift, usually students taking 'computers' at school, as well as those who have discovered them at church rummage sales or flea markets selling at a very cheap price. A lot of practical information has been acquired over the years by user groups*(the writer a member of the defunct OHTSUG), on the ins and outs of this sometimes most temperamental of computers, and these tips are worth passing on if new users are to get the value from these decade old computers. A single tip may suffice to get yours working!

As a secondary consideration many wish to acquire a degree of computer literacy and do so on a slender budget. Textbooks that use as illustrations of their theory, the IBM 360 mainframe or other commercial computers as famous or not-so-famous, do not allow any but a handfull of readers any access to the machine in question to try it for themselves in the course of hands-on experimentation. The ZX-81/TS1000, with almost 1 million manufactured, offers a greater, and cheaper and more easily found opportunity to get hands-on experience.

So for the first time user, the thinker about computerization and its still future potentialities and the armchair theorist, here is a little something to get your ZX-81/TS1000 humming, to add to theory, practice.

There is no guarantee of any kind, expressed or implied that the writer or any of those who contibuted ideas to this book/booklet have not made grievous errors of comprehension or specific detail in any of what follows. Consider it rather as like a friendly chat over the back fence rather than as any terrific much less infallible source of truth. There are very few, even among technical people, who have not misunderstood or otherwise been mistaken in their interpretation of this or that piece of booklearning concerning any really complicated field. The fields of electronics and computing, certainly qualify for inclusion in this class and it is daring if not foolhardy the writer admits, to tackle such a writing and explaining task almost singlehandedly; but it is worth the try, I think. You be the judge.

The chapters follow a somewhat planned (and replanned as changes were made) order but the sections are to a certain extent free standing and can be read in isolation, at least by someone of a little experience with this computer. If you can sit down and read it through good. If you just want to hop around as subjects attract your interest , good too. But this book/booklet should be just one source of your knowledge in the field and should be continually supplemented by external sources, both print and in person (the user groups are a good place to start).

Take care and above all, enjoy your computing hobby.

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* Addresses(1991) of: SNUG (North America Sinclair User Group), c/o Paul Holmgren, 5231 Wilton Wood Ct., Indianapolis, IN, USA 46254 and of the Toronto Sinclair User Group, c/o Mr. Geo. Chambers, 14 Richome Court, Scarborough, Ont. Canada, M1K 2Y1, (the Ottawa-Hull User Group, OHTSUG disbanded Feb.,1991 although the former club BBS stays), SLIX (Info Exchange), c/o Bill Miller, 6675 Clifford Dr., Cupertino, Calif., USA 95014-4530.

A Small Part of The Fascinating Story of Sir Clive Sinclair

Sir Clive Sinclair,(he was knighted and so authorized to be called 'Sir' by Queen Elizabeth's government in recognition of his technical wizardry), is an enigma and someone who as both an entrepreneur and a technical genius is not well understood in his own country except as an eccentric. In Britain anyone who is interested in technology is definitely off the main stream and someone who is an entrepreneur is (or was up to Prime Minister Thatcher's time) considered suspect, so that someone like Sir Clive who is both would be regarded as eccentric to say the least.

Starting as a technical writer, Sir Clive got into the design and manufacture of kits for hobbyists including hi-fi's, pocket calculators and digital clocks all of which had a fine reputation for advanced design but which eventually lead his firm into bankruptcy. Picking himself up with a new firm he got into electric cars, pocket t.v.'s (the latter of two designs using a unique flat, sideways scanned picture tube) and the subject of this piece, home computers.

The ZX-80 came out in 1980, had 4K integer BASIC in ROM and 1K built-in memory expandable to 16K. It used an audio cassette for input and output, to save programs to tape and although not much seen on this side of the Atlantic, it had quite a following in Britain, with many books and even some magazines spilling technical ink over how to use it, modify it, fix it and learn about computing with it.

The one that we are more familiar with is the ZX-81 (under the Sinclair nameplate) or virtually the identical computer, the TS1000 (under the Timex nameplate). Timex in Scotland had put together the ZX-81's and seeing what was going on contracted with Sir Clive for a piece of the action. The ZX-81/TS1000, which is still in use by many diehard users and which had about 1,000,000 manufactured (with new ones still on sale through surplus dealers), had floating point BASIC in an 8K ROM, and was easy to program and cheap, cheap, cheap — opening up computer use as a hobby to many more than could afford a regular price home computer. Starting off at about $300, prices for a new TS1000 went down as far as $35 towards the end. It was discounting that drove it out some say. How can any store offer the support needed for first time computer users on a profit margin to be squeezed into a $35 selling price? Hence a lot of complaints, probably unrealistic that it was never properly supported.

The Sinclair firm then produced an improved home computer for the British home market, the Spectrum which started out as a 16K computer and ended up with 128K versions using still the Z-80 that Sir Clive had used in all his computers up to then, but the Z-80H version (rather than the Z-80A), which could run at 8 MHz (versus the 3½ MHz of the ZX-81/TS1000). The Spectrum was never exported to the USA (in any real way, a few American versions do exist) but instead one with a nicer case and better looking keyboard, and different (and therefore only partially compatible for program use) ROM, the TS2068, came out. For a while an upgraded model the TS1500 came out in between the two. The TS1500 was really just a TS1000 in a fancier case, with built-in 16K of RAM (versus the necessity of using a RAM pack to get 16K with the ZX-81/TS1000) and a slightly modified ROM. Many TS1000 users upgraded to the TS2068, a computer roughly in the category of the Commodore 64 but with an easier-to-use BASIC built-in. It was the first colour computer for Sinclair (in the USA), and allowed about 34K BASIC programs to be used and like the Commodore 64 managed to get more than 64K of ROM plus RAM mapped into the 64K memory map space by using shadowing (double-mapping part of the memory).

The QL, a terrific computer using the 68008 microprocessor (8-bit bus version of the 68000 of Atari ST and Macintosh fame), had lots of buyers among Sinclair fans but relatively few outside in America. It appeared about the time that Sir Clive had to sell his debt ridden company to Amstrad due to financial difficulties and while the new owner, Alan Sugar continues to push the Spectrum line, he has lost interest in the QL. As for Sir Clive, he has started a new company under the name Cambridge, and is making the Z-88, an LCD laptop, using the Z-80 and some new ideas....

What Kind Of Computer Did You Say You Use?

I guess all us users of low-cost and orphaned computers have learned to dread what comes next, when we tell people the make and more about our computer. After we say, a Sinclair or a Timex we have probably heard all sorts of variations on: -'oh, the doorstop,"oh, that little thing,"oh I thought you meant you were serious about computing'? or even worse, 'I thought you meant a real computer'.

There are two possible responses to this depending on where it is coming from. The non-computer enthusiast or non-hobbyist, inexpert person one can write off as just being ignorant of the finer things and the subtler points and uses of computers. The expert or work oriented user, and many will not give your admission of Sinclair ownership any flack or ribbing at all as a response, if of a critical inclination will, once pressed perhaps admit that he would say the same to any computer owner who did not 'program in FORTRAN on mainframes', 'have a real supercomputer or mainframe to use' or 'own the flavour of the year, usually either an AT or a Super Mac or some such'. The rest are kibitzers who have read a lot of articles on computers in the deeper technical magazines like Time or Reader's Digest, (if they go in for periodicals with pictures smaller than the print area at all), and if you don't have more megs, higher turbos or this or that accessory, they realize that your conversation with them will give them no material that they can impress the kids at the ice-cream counter or gang at the water cooler with. They are looking for anecdotal material of the sort, "Last week I met this guy who built a Cray XMP in his basement from spare parts smuggled out of the office...." There is no response to this sort,①but a shrug.

But we need not apologize for using a computer that has memory capacity even at one or two kilobytes, as large as the computers that kept bearded Ph.D.'s in white lab coats busy and made them look wise in the articles on the subject in the 1950's. Your TS1000/ZX-81 is also faster, and has a built-in operating system command language (a development of the time about 1960 or later for big computers) and a programming language which would be the envy of the programmers in the 1960's who struggled with FORTRAN I. Into the bargain it would increase their productivity five fold. Waiting-for-the-print-out-blues, was a real problem in those days. You keyed in your program on a key punch machine (no fancy text editors then), took them to the computer room in basket, and waited a day or more to see if the program would work at all, and then repeated the process for each successive bug fix. How much nicer now to get your 'computer run' back in 5 minutes if not 5 seconds, with a Sinclair/Timex or other similar orphan?

Believe me, the Timex/Sinclair can be the platform for any degree of software sophistication you can handle, from writing your own word-processor or database program or spreadsheet, through to machine language programs to compile a new computer language or give your computer a multi-tasking operating system. All these things have been done by the way. And off the shelf database, spreadsheet and compilers are available like Vu-File, Vu-Calc, and Partial Pascal, to name three of these. Assemblers and machine code monitors exist. Even a multi-tasking operating system (Nova 1000). On the hardware side you can still get everything from disk drives and 64K memory packs to plans for EPROM burners and cartridge adapters. Speech synthesizers, good (movable key keyboards), modems for communicating with Bulletin Board Systems over the phone, monitor adapters, Centronics parallel printer ports, RS-232 ports, and household appliance controllers have all been made at one time or another for these computers and are often available surplus or used. The commonest accessories, a 16K RAM pack and a thermal printer are freely and more easily available through user group contacts.

Don't look down on your computer or apologize for it. It has the capacity to handle all the sophistication anyone is likely to throw at it. The features that it doesn't have and say an IBM PC does are largely labour saving devices that can be replaced in the TS1000/ZX-81 by clever machine code routines from books or magazines. Buying an IBM PS/2 Model 50 to experiment with is a bit of overkill, a bit like buying a sawmill to make a single bird house when an old-fashioned hand-saw would do. Let others scoff. Just enjoy.

What To Use A TS1000/ZX-81 For?

The question to start with is probably not the above one but the question, "Why doesn't everyone use a TS1000?" The answer is that newer computers with more features: faster calculating speed, colour displays, more memory — have allowed longer and more complicated programs to be developed that need that extra capacity. Once the trendy programs are being written for other computers the market for your computer will drop off. No new software, no new computer sales for that model to use that software, — that is the rule. It certainly does not imply that a TS1000 has no use or is no good. On the sort of software that it will handle it works very well indeed.

The spreadsheet program Vu-Calc, quite adequate in capacity for most home use is available for it and the file card style database, Vu-File is also available. Vu-File will allow about 100 file card style screens of info or closer to 200 if less data is included, with a TS1000 with a 16K memory expansion RAM pack. These programs are written mostly in BASIC and are quite fast.

The programmer's products such as assemblers, disassemblers, integer BASIC compilers, (integer) FORTH compiler/interpreters and LOGO interpreters are all available. A subset of Pascal, Partial Pascal was also produced at one time as was, a C compiler (Tiny C?). These latter may be harder to find but still turn up on the used market every now and then. So a person who wants to experiment with different programming languages as well as the very excellent and easier than average to learn built-in BASIC has material to work with.

A wide variety of programs from astrology and numerology to simple games often adapted from those run on mainframes in BASIC in the 1960's-1970's through all manner of scientific and engineering programs have been made for the TS1000. Many are available from user group libraries on tape or in books or newsletters, or books available used, remaindered or in libraries.

Perhaps because of the poor keyboard of the original TS1000/ZX-81, little has been available in the way of word processors although a few exist as does a desktop publishing program.

As far as software is concerned most users seem to come to the TS1000 as a learner of BASIC or machine language programming (Z-80 microprocessor instruction set) and use the computer to supplement their school work in that field. It is an opportunity to get extra hands-on time on a real computer and do real computer programming at very little cost.

A whole other field is that of hardware hacking. Some have used the TS1000 to control burglar or fire alarms in their homes or just to experiment in hardware interfacing electronics. People who would start to panic if they had to take the cover off a $1000 plus, IBM AT clone, due to the low cost of the TS1000 and plentiful supply of them on the used and surplus market are not so intimidated by the TS1000. Blow it up and you are out $30-40 or so and that is all. That is much more conducive to experimenting with harware modifications and add ons that the prospect of watching $500 worth of chips blow on an AT clone due to a slip of the screwdriver! In addition many books on hardware modification that directly or indirectly relate to the TS1000 have been published and many articles in user group newsletters and back issues of electronics magazines are also their to guide you. (Look at magazines in the 1981 to 1986 period for these articles.)

What the TS1000/ZX-81 will do is basically similar to or better than what the early business and scientific computers of the 1950's and 1960's were capable of. Within this class of work its performance is nothing to apologize for. The advantage for the owner is that unlimited computer time to use and experiment with such a class of computer is now available through the TS1000 for less than $100. The earlier computers would provide the same facilities for less than $1 million and as a consequence were only available to a select few in universities, colleges, or research institutes. The TS1000 offers the same opportunities to even a young person who can buy one with a little pocket money, otherwise wasted on junk food.

The Sinclair ZX-81/TS1000 Today: A Unique Orphan/Classic Computer

As this is written in 1991 it seems that it is all over for the Sinclair ZX-81 or Timex TS1000, or is it?

As a hobby computer, with the availability of Commodore 64's and even cheap, IBM compatibles, much more sturdily built and better looking computers, than the old Sinclair design, and better supported in the way of saoftware, where does the ZX-81/TS1000 stand? There are three things the ZX-81/TS1000 has that the others do not. Price advantage, at a price that even used Commodore 64's has yet quite matched on the used market, size, is the second, and repairability-survivability. For that reason a student can use one to practice BASIC (and even machine language) programming, even if the keyboard is going and the cassette interface is broken electronically. Testing the effect of simple BASIC instructions and PEEKs and POKEs is more useful to the learner than all the incomprehensible books and lessons in the world, and it is discovery-based learning that children take to. And so if junior wrecks the old ZX-81/TS1000, there is not the family upset that would ensue if junoir spilled junk food into the family IBM or Mac! (The writer still uses the ZX-81 to test algorithms.)

Apple II's and IBM compatibles have an achilles heel in their power supply. These switch ing power supplies are expensive to buy, hard to fix (and a shock hazard to even open up), and very much subject to going down, either when used during a distant lightning storm, or just through age. The ZX-81/TS1000 power supply is also vulnerable, but a replacement for the wall unit can be built by any technician out of parts available from Radio Shack (such as the # 273-1511 transformer and a couple of 1N4007 diodes, and a big filter capacitor or two), and if the voltage regulator inside the computer goes, simply replacing it with another 7805 (Radio Shack#276-1770) may be all that is needed there. Switching power supplies are so hard for even technicians to fix that no technician will guarantee to fix one, and mostly they are just replaced, holu-bolus, the whole p.s.u. board from your computer just going into the garbage.

Finally due both to the simplicity of design, the availability of assemblers and other debugging tools the ZX-81/TS1000 is a good computer for the amateur and student to use for electronic computer control projects. Eproms for it are cheap and coming into the surplus market too as are CMOS battery backed up RAM's. Its physically small size also makes it good for controller use although some have made even a shorter board to run programs created on it from. Books like Ciarcia's based on old Byte magazine articles, British electronics articles of older vintage, and "Timex/Sinclair Interfacing" by Downey & Rindsberg, Prentice-Hall 1983, and"Radio and Electronics" and other North American magazines of that time, all provide lots of wiring diagrams and other assistances to the hardware experimenter. This makes controller projects a lot cheaper than the $600 boards and $1000 development system software sold to commercial developers these days, and puts computer controller development into the hands of the many rather than merely the well-off.

Unfortunately the best resource for getting the amateur help in using the ZX-81/TS1000, the local user groups, have vanished from most cities. Suppliers still exist though and a few contact addresses are given below.

Disk Drive Systems for the ZX-81/TS1000 -The John Oliger Company, 11601 Whidbey
Drive,Cumberland,IN,USA 46229

Winky board to aid cassette loads etc.-Russell Electronics, RD 1, Box 539,
Center Hall, PA,USA 16828

Parts, Accessories, Software: RMG Enterprises, 1419½ 7th Street, Oregon City,
OR,USA 97045

Repairs, Mailorder Service: Promise Land Electronics, Route 1, Box 117,
Cabool, MO,USA 65689

User Groups: Canada: Toronto TS Club, c/o Mr. George Chambers, 14 Richome Ct.,
Scarborough, Canada, M1K 2Y1 (Newsletter, out-of-town memberships accepted)
USA, etc., World-SNUG, Sinclair North America User Group, c/o
Mr. Paul Holmgren, 5231 Wilton Wood Ct.,Indianapolis,IN,USA 46254

What Have We Got Here?

This is the section that you should read if you are just unpacking a Sinclair ZX-81 or Timex TS1000 bought at a flea market or garage sale or loaned by a relative or friend after a long period of lack of use. The logical thing to look at is whether you have **all** you need to make it go for without this it makes little sense to look into problems in getting it to go or whether it is broken or not.

The standard styrofoam packed beginners set from Sinclair or Timex includes the computer inside a keyboard unit case (plastic), a video cable (RCA plugs on both ends), a computer/t.v. switch and a 9 volt (at 650 m.a. or more) power supply that plugs into the wall at one end and using an earphone style plug, into the computer at the other (9 volt) end. The computer is used typically with an ordinary television set (black and white or colour-although with a colour display the image will only be black and white). Depending on the vintage of the computer either an ordinary t.v. will suffice to receive the video output on either (v.h.f.) channel 2 or 3 or on a u.h.f. channel (which not all old t.v.'s are capable of receiving). The way to tell is in reading the instructions that once came with the set-up and now probably lost, talking to the previous user (if they can remember) or looking at the bottom of the keyboard unit for a switch (between channel 2 or 3) to indicate those channels or now switch that will indicate a u.h.f. model. Some people prefer the u.h.f. models others the v.h.f., so don't feel bad if you have one or the other.

One of the most troublesome items to use with the computer is the cassette recorder. Ordinary double audio cables, with male (plug in), audio plugs at each end are used to connect the recorder with the computer. Here is where the fun starts. Many recorders aren't of the right kind or in good enough condition to be capable of being used with the Timex-Sinclair computer. It doesn't work best with expensive or with cheap recorders but only experimentation will show if the one you have will work. In addition some computers have the interface chip ports blown, often because of too much plugging and unplugging of the plugs to and from the computer and cassette recorder.*① In addition, adjustment of the volume control is very critical and should be set neither too high nor too low (¾ high is often around the best setting). When you find the best setting you will want to mark it with paint or something. If the cassette recorder has a tone control, set it on maximum treble (high pitch). Much of the rest of the tips in this book will be centered around problems encountered when recording or saving a program. You can however use the computer without the recorder. You just will have to save any program by, say copying it off the screen by hand on paper and then keying it in all over again in the next session. This may well be all that you need if you just want to explore some of the BASIC language commands in order to supplement a programming course at school. But getting the recorder going will enable you to become a real programmer. [*①A blown interface chip often records with a low tone, see p.5+]

Among the various other accessories such as ZX-Printer (thermal printer which uses special silvered paper), TS2040 printer (thermal printer using special, white, treated paper), metal keyboard and case, etc., the most common and most useful is the expansion memory pack, the RAM pack. Timex 1016 packs are 16K. Various other makers have made 16K memory expansions for the RAM. Some have made 32K and 64K RAM packs. The computer itself has 1K or 2K of internal memory built in, depending on its vintage and the 1K memory will allow say 1½ screens full of program lines to be contained in the unexpanded computer.*② Generally speaking (but not always) the size of the memory is the size of the RAM pack used (that is they don't add up, a 1K computer with a 16K RAM pack will have 16K of RAM memory not 17K). RAM packs should (as with most computer accessories) never be plugged in or unplugged while the computer is powered up (plugged in to the power supply). Forgetting this risks damage to the computer, the accessory (in this case the RAM pack) or both. It may not happen the first time you do it, thus lulling you into a false sense of security and then one day, zap! [*②(4/-, error msg.-out of memory).]

And of course the computers came with a user's manual. If you don't have one, try a user group. They might be able to get you at least a photocopy if not an original.

Preventing ZX-81/TS1000 Crashes

Nothing is more annoying than to have spent an hour or more working on a program only to have it vanish when the computer is locked up or cleared due to a crash. One solution is to save your program every 20 minutes or so, so that only 20 minutes of work at the most is lost. However due to the slowness of cassette saving this can be very frustrating especially on a long program that uses up most of the 16K memory. One other solution, an expensive one, but the one the writer uses is to save your program on a Larken disk system which only takes 7-10 seconds.

But of course an ounce of prevention is worth a pound of cure as far as crashes are concerned and this article will look into the various causes of crashes and their prevention.

RAM pack wobble is probably one of the leading causes of crashes. The LARKEN disk interface board relocates the RAM pack away from the keyboard and its vibrations, so that this is an extra dividend from using it. Another fix is to install some sort of bracket, either a piece of wood or metal, taped or glued on both the RAM pack and bottom of the computer with removable glue. A screw on mount is also feasible. Some RAM packs and some accessory keyboards are more prone to this problem than others but it is still an annoying one. See bottom p.16 for an idea on this too.

Another source of crashes is the software itself crashing, particularly those written in machine code like assemblers, FORTH compilers, etc. Again saving on disk and transferring the assembler or compiler to disk for quick reloading seems like the best method. Other than that. the fixe listed under spike suppression might be tried.

Spikes can be generated on the electrical power line by storms or simply by a furnace or air conditioner coming on. As well, furnaces or air conditioners when they come on must start their motors, and as the heavy starting coils are switched on drawing extra current, the circuit that your computer is on, if it is the same one, will show a momentary drop out or loss of power, perhaps enough to crash your computer.

Spikes can be guarded against by MOV transient suppressors. Such devices as Radio Shack Cat. 61-2791 or 61-2785 or similar products built into power bars may help. The writer uses in addition to that a MOV accross the 12v plug into the computer. An Active components, MOV of 14VRMS, stock # 10130, seems to be easy to obtain. One warning, is that these MOV devices tend to fail themselves, and if there is no fuse in your system to protect your power supply, it may blow the 12 volt transformer system too when it goes. A ¾ to 1¼ amp fast-blow fuse in the line between the MOV and the power supply should prevent this. *

One of the ways that spikes can cause crashes is by putting glitches or false triggers into the microprocessor. Some people recommend replacing your Z-80A microprocessor with a Z-80B which can be bought at parts dealers that stock Zilog. This will not speed up your computer but it should accept shorter and even interrupted pulses better without crashing.

One way to avoid both crashes and glitches from the hydro line is to run your computer from a battery. Some people have tried running theirs from car batteries. However the hazard of gas release while using a car battery indoors, with the danger of a possible explosion make this a rather exotic solution that is not recommended.

As far as the momentary loss of power or brown out problem goes one solution is to try to move your computer to an electrical outlet that is not on the same circuit as the furnace or airconditioner causing the problem. Another uses an uninterruptible power supply (autoswitching battery back up using flashlight batteries and a couple of diodes). Plans are

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*A leaky (partly shorted) MOV can also reduce the supply voltage producing many funny symptoms like poor disk saves and peripheral problems. Check MOV first in case of problems by removing it from the power circuit. Choosing a fast-blow fuse is experimental and depends on p.s.u. capacity-rule is typically to choose the smallest value (least amps) fuse that will not blow every time you power up a computer-p.s.u. system with no abnormal or short condition present. (p.s.u. = Power supply unit).

Preventing ZX-81/TS1000 Crashes (Continued)

available in some of the old Sinclair magazines and newsletters and in the book, SyncWare News Vol.1 June 1983-June 1984, a collection of newsletter articles available from Thomas Woods. Someone in your user group may have a copy of this to lend you.

One more problem is heat, when running your computer on hot summer days. The power to the main part of the computer is fed through a 5 volt (part # 7805) integrated circuit voltage regulator. This radiates heat to a large piece of aluminum near the "1" key on the computer. When you feel this area of the computer getting hot, it might be a wise idea to shut down the computer and give it time to cool off. The integrated circuit mentioned has an automatic shutdown circuit when it senses that it is getting too hot and will at that time shut off power to the computer. Solutions include working in the cool of the basement in the summer and taking your computer out of the case for better ventilation and even instling the voltage regulator on a bigger piece of metal or commercial heat sink. If you leave your computer on for several days in hot weather you may find that the voltage regulator is finished altogether. Luckily it is not a hard job to replace it for someone with some electronics experience and the 7805 can be bought at nearly any store (Radio Shack stock # 276-1770, and also stocked by nearly all stores & UA-7805 for Addison).

The 2nd commonnest source of crashes that the writer can think of in a cold climate anyway, is associated with cassette operations. In particular the cassette jacks at the side of the computer sometimes get loose resulting in intermittent contact and failures in loading or saving if the cable or computer is jiggled. The solution is to open up the computer and tighten them with a fine screwdriver (bending the prongs back where they belong). You do not have to pull out the keyboard to do this if you are careful and simply undoing the screws under the rubber bumper legs under the computer and partially openning the case halves will give you enough room to do this operation, a sort of minor surgery of the computer world. A temporary fix is just to hold the cable plugs firmly and steadily while using the cassette with the computer, holding the plugs against the contacts as it were. See p. 7 , on the loose jack problem and fixing it.

Software crashes in machine language or compiler programs of course is not preventable are at least amenable to such counter measures as saving your program before running it or simply writing down what you have written off the listing if it is a simple program. In fact that is a good rule for BASIC programming too, the time to save a program is right after you have made your changes or fixes and before you test it with a RUN, since it is usually the running and not the altering that will result in a crash.

It takes only a momentary loss of power while the computer is running or loss of contact of the cassette recorder jacks while loading or saving to result in a crash or load/save failure. See p. 7, for loose jack problem. The ULA can be destroyed by plugging/unplugging mic/ear jacks under power.

One kind of crash is where your computer runs okay until it has been on for a while and then crashes. Hardware problems associated with this include overheating of the 7805, the ULA chip or the power supply you plug in the wall. Bigger heat sinks and running the computer open case (with an accessory keyboard) may solve these problems although the chip may be too far gone (or the powersupply) when you reach this point, and may have to be replaced with a new one. Adding a heat sink (or a bigger one in the case of the 7805 or relocating the 7805 and heat sink outside, have been tried over the years for the integrated circuit problems. A difficult-to-spot problem is momentary loss of power due to loose power input jack. Just fix the jack (see p. 7, on the loose jack problem) although some have tried replacing the jack connection with a sturdier or directly soldered one although this is for the technician only to tackle.

A purely software crash can result in two conditions:-when the BASIC program gets longer than 32K (even with a 64K RAM pack attached) and when a program crosses over the 16K size, in a 32 or 64K RAM pack. See the RAM pack instructions for the fix on this latter. For the former, stay under 32K. (of Basic)

Hazards of Handling Cassettes And Diskettes

Many of the problems that people get into in terms of poor program loads and unreadable saves is based on mishandling the magnetic recording media. Most people have been warned strictly on the dangers of diskette handling, keeping them away from heat and magnets, keeping the fingers well away from the recording area of the coating and keeping dirt or dust away from them. Fewer people realize that all these cautions apply to the less finnicky cassettes as well, in addition to a few new ones.

The special cautions for cassettes are starting the recording/saving away from the first of the tape where the poorest quality (on the first several turns of magnetic tape) is found. Also of course don't try recording right at the start, either, on the plastic (uncoated) leader that some tapes have - no magnetic coating, no recording possible, obviously-but how many people in their excitement forget? Another special caution is to avoid tape that is too thin, such as the 120 minute cassettes (30, 60 or 90 are workable, 120 stretches and results in errors).

Everyone by now knows enough to keep their cassettes or diskettes away from magnets, but then you put one on top of your cassette recorder, unaware that at the top of these, under the speaker holes is usually a speaker with a powerful Alnico, permanent magnet (that is, one mangetic whether the recorder is turned on or off). And then you wonder (as the writer did once) why that brand new program tape from the mailorder company, won't load! The same applies to radios, especially pocket radios and their magnetic speaker hazard, commercial advertising on refrigerator stick-on items, transformers in your power supply, switching power supplies, etc. - all are magnetically hazardous to cassettes or diskettes although you might not expect it.

Dirt is a big hazard. Diskettes can be ruined by particles as small as the smoke particles from cigarettes, although cassettes whose head gap clearance margins are much higher are also subject to dirt. Most dropout in diskettes is caused by dirt put on in the home rather than the manufacturer's plant where the diskette is kept in clean rooms prior to packaging. You might however look out for small paper clippings from the diskette envelope manufacture or other white particles, and carefully remove them before they get onto the magnetic surface of the diskette. This seems to be a hazard with some brands of diskette particularly seconds or bulk diskettes. And finger prints on the magnetic coating are especially to be avoided on both cassettes and diskettes. Keep your fingers well clear when you load the cassette into your machine!

The question of whether to use expensive diskettes and cassettes or cheap is a judgment call that you will have to make. Many people swear by cheap ones. You will find out if their is a problem with a specific brand or type rather quickly on using them. Cheap cassettes seem prone to jamming. The writer has always used the cheapest ones and relied on experience to sort out the good from the bad. Others, won't touch cheap tape or disks at all, since they don't feel that taking a chance is worth the hassle. What price frustration?

Heat, such as putting a cassette or diskette on top of your monitor or television set, is definitely a no-no. Ofcourse radiators, electric heaters, ventilators in which hot air comes through or circulates in, all these are the sort of things that common sense should tell you to avoid. People hower often forget that a locked car in summer will heat up a cassette or diskette enough to obliterate its magnetically stored data. The writer even saw a cassette recorder left in the back window of a car in which the plastic had melted so much that you couldn't open the cassette door (it was distorted so much by melting). That back shelf under the window of most cars is no place to store magnetic media.

Follow these tips and you will not be blaming the manufacturer, the disk or cassette unit or the software house when the problem of program loading or saving could simply be due to an error in your procedures for handling the disk or tape, or simply a lapse in following them.

CASSETTE BUGS AND FIXES

One of the most frequently encountered operating problems with the ZX-81/TS1000 is the failure to load a program from cassette. However, over the years a fair amount of folk wisdom has accumulated on how to solve these various problems, from using fresh tape for saves, to... (read on).

One of the most obvious problems is that the loading never works. The simplest fix may be to buy a new cassette recorder. Another problem is intermittent loss of signal—the computer seems to be loading all right for a while and then suddenly loses it and the screen may go blank. This can be caused by a loose connection in the prongs in the cassette cable jack. Luckily it is a fairly simple matter to open up the computer and bend these gently back into position with a miniature screwdriver.*① The third major problem is perhaps saving with a funny noise on replay rather than the regular tones. This can be caused by failure of the ULA silicon chip which can be simply replaced with the same part from Sinclair or a supplier of Sinclair parts merely plugging into the old socket. (*① Also wrong volume setting.)

What do you do when you save or load? Maybe to avoid noise you use only one cable at a time. This is said to help some problems but on the other hand it seems that it is the plugging and unplugging of the cables while the computer is powered up or the recorder playing that causes the ULA chip to go prematurely (see above). Some recommend running the cassette recorder on batteries to cut down on power line noise and ground loops. Then one adjusts the volume to the appropriate level. The custom is to find the optimum recording and playback level (usually ¾ of maximum volume, tone control turned up as treble as possible if the cassette machine has a tone control) and this may take some experimentation, and then mark this point on the volume control with white typing correction fluid or nail polish. But having tried all this with no results there is still one more adjustment usually performed only by audio technicians for audio recording and that is the head azimuth. But we will come back to that in a minute.

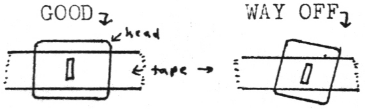
Other possible bugs will be considered now. Do you have a suitable tape recorder. Any form of stereo recorder is no good (except for erasing tapes). Reel-to-reel and microcassette recorders also should be avoided unless you want to experiment. Cheap cassette tape is usually no problem (although in some marginal cases, better tape may help, particularly with very long programs, 10K or more). You are best to use tape less than 120 minutes since stretching of that thin tape can result in data errors. But you need not use the expensive special computer tape. 60 minute for regular use, 90 minute tape for safety back-ups is okay. It is said that some tape recorders with certain automatic volume control circuits won't work. But when buying a recorder cheap is usually okay as long as you have an ear or ext. speaker jack and a microphone jack. "Monitor" jacks may not be the same as ear outputs and may not work. Read the owner's manual before buying if there is any doubt. Some cassette recorders especially those marketed by Radio Shack are specially made for computer use. A VIC or Commodore 64 "Datasette" will not work.

The cassette recorder must be well maintained too. If the cassette tape gets tangled up in the mechanism that is a sign that you haven't cleaned it in a long time. Swabbing the rubber roller and metal parts with a cotton-tipped stick wet with alcohol (rubbing alcohol, isopropyl alcohol) is the solution. Also demagnitizing the head may be required. Special devices to do this may be purchased for about $10. Disk drive head cleaning is trickier.*②

The tape itself may have been abused. Leaving it near the speaker of the cassette recorder itself with its powerful alnico permanent magnet may be enough. Letting the tape get warm or leaving it on your tv or monitor or near a stereo speaker may also screw it up. Don't save on used tape!

②*And ordinary rubbing alcohol should definitely not be used on disk drive (or VCR) heads, since in the 1980's drug stores started putting water in rubbing alcohol (including isopropyl), head oxidation-corrosion resulting!

What is head azimuth? Ans.:



Many loading problems particularly with commercial software can be solved by adjusting the cassette azimuth. However once the azimuth is changed, you probably will never be able to get it back to its original position. Azimuth simply means the angle from the vertical of the recorder head. There are two types of adjustment, to optimize the adjustment for most ZX-81/TS1000 recording and playback or to optimize to bring the azimuth-closest to that of the machine that recorded the hard-to-load tape (that machine may have been way off). If your machine works well for most tapes it would be wise to leave it like that and adjust the azimuth on an older machine if you are trying to load a single baulky tape. Many ZX-81/TS1000 users have two cassette recorders one for which the azimuth has never been or had to be adjusted (the good machine) and another to adjust the azimuth for the odd hard-to-load tape. Once you have adjusted the azimuth you may have to reajust it on almost every load after that!

The easiest adjustment to explain is the adjustment of azimuth to match a hard to load tape. Put the tape in question in the machine. Play it into the computer. And adjust the azimuth screw while it is running until you get after a number of trials proper tape loading. The screw is usually located through a hole in the cassette recorder body near the record head (you may have to have the cassette door up) and is reached with a jeweler's screwdriver (when the machine is playing only). You should not turn it more than one half turn either way.

To try to adjust the azimuth to optimum setting for general recording if it is screwed up, adjust while you play a computer tape until you hear the most treble and hiss.

If you are really into electronics the proper way to do it is to put a multimeter set on output or volts accross the speaker (or across a 24-50 ohm dummy load atthe external speaker or ear jack with an extra earphone plug) and adjust the azimuth for the maximum meter deflection (most volts or db).

There are also various tricks and accessories. An audio output transformer may be used*①between the cassette on play and the computer with the 8 ohm side to the ext. speaker and the high-Z side to the computer (Radio Shack Part No. 273-1380, the 8 ohm side has 2 leads the other three). This has been recommended① for use with the TS2068 in baulky loading or uploading of ZX-81 programs. (*①It can overload the ZX-81 ULA chip or recorder rui

Russell Electronics sells a Winky Board which helps condition the interface signal and helps you find the optimum volume control level with a minimum of adjustment. (Russell El., RD 1, Box 539, Center Hall, PA, USA 16828.)

Some people say a longer cord should be used. Some say transient suppressors help. Some add certain filters to the line of a homebrew type.

In fast load mode there is one commercial cassette fast load which comes with a special piece of hardware which it requires. The Turnbull fast load Z-80 m/c program (double regular ZX-81/TS1000 speed) is very touchy about recorder condition, azimuth and volume control levels.*②

Loading with the TS2068 often will not be successful in difficult cases when the computer has been on for a while and is hot. The solution is to turn it off for an hour or two and try again when it is cold. Also the TS2068 cassette system seems prone to problems with glitches, brown-out (power voltage drop) and too many accessories mounted on it power supply bus. This is particularly a problem with the cantankerous ZX-81/TS1000 upload programs which load ZX-81/TS1000 tapes at the regular speed to convert the programs to TS2068 BASIC. (Note the TS2068 is a completely different model.)

I hope that this compendium of home-cures will help you. If you have heard of any others that work the writer would be interested in hearing.

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*② Mr. Bill Turnbull, a former Ottawa-Hull TSUG member kindly turned over copies of this program, after giving a demonstration of it, to the OHTSUG software library. Note that cassette save reliability was improved in 2068 with its fast baud rate by adding wave shapers and changing modulation.

ZX-81/TS1000 Loose Jack Problem-The Fix

The three jacks on the side of this computer that accept mic., ear and power plugs are of a somewhat flimsy construction that may become apparent after a few years of use (or earlier on rough usage) of the computer. The cure is fortunately rather simple for the mechanically/electronically handy user or technician.

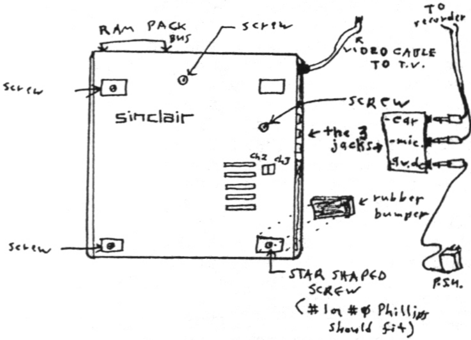

Fig.1 -ZX-81/TS1000 Bottom View
(the 5 screws to remove)

The Fix: Step 1 - take the bottom half of the case off (without removing the printed circuit board inside or the keyboard membrane plastic sheet at this time). There are 5 screws that must be removed from the bottom of the case. This is not as easy as it might seem since only two are visible. The other three are found under the rubber feet (rectangular strips glued on near the corner). These can simply be pulled off in order to remove the screws under them. Once the screws are completely removed, the bottom half of the plastic case should separate with only light prying. Any force indicates that the screws are not completely removed. See Fig. 1.

Step 2 - The printed circuit board is now secured to the top half of the plastic case by two screws. See where they are (upper to mid-, left near the RAM pack opening and near the centre, more towards the middle of the case, typically). For reassembly, note where they came from, with a soft pen say).. The printed circuit board must be moved up and away from the top half of the case about one or two inches only (so as not to disconnect or damage the fragile keyboard matrix/membrane plastic from the connector on the board)- Fig.2.

Step 3- holding the printed circuit board so that one can see the three little plastic boxes that house the jacks, any prongs that are bent too far up and out, may be carefully pushed back into position with a small screwdriver or toothpick. Several pushes back may be necessary until the springiness is overcome in its attempt to reposition the prong outwards. Now test the jacks with the cable for the cassette recorder (no power applied) for mechanical fit.

Step 4 - Now you are ready to reassemble the computer making sure that the two screws for the printed circuit board are not inserted in the holes meant for the outside, bottom shell of the case, screws. If you put one or both of these screws in the wrong place, the screws will not all go in when you try to screw the back on again and all the screws on the outside will have to be removed and the bottom taken off again to find the source of the problem. Do not disconnect the little metal bar or whatever, that ground contact with the metallic paint inside the case that provides some measure of protection from RFI for the t.v. etc.

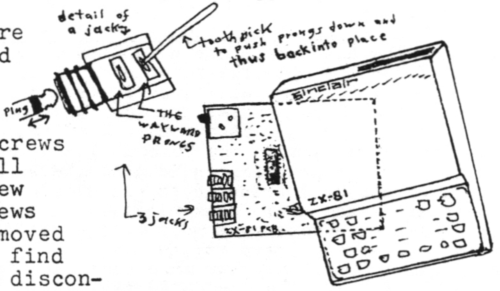

Fig.2-The Three Jacks Inside,
On the Circuit Board

Step 5 - Once the printed circuit board is secured inside the case with its two screws and the bottom of the case secured with its five screws and the little rubber feet or runners stuck back on, you are ready to test the computer to see if the original problem is fixed (and no new ones added).

Note that a loose power jack into the computer can also cause the save/load crashes and some users have either tightened up that jack too, or replaced it with hardwiring the power supply wire to the p.c.b. and adding some safety device like a switch on the line or pilot light (standard LED and ½ watt, 1K ohm for example) to make sure it is not left on.

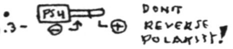

Fig.3-

Cassette Recording Principles Affecting Computer Users

The early recording used wire recording with an iron wire. Now, tape is used with a metallic particle or more commonly a ferric oxide (iron oxide) coating placed on a plastic tape base as the recording medium. But the principle is the same. An electromagnet called the record-playback head forms little permanent magnets in the tape coating, as it passes the head, by induced magnetism, much like that made by winding a coil of wire around a screwdriver and running a battery current through it to magnetize the head (so it will pick up stray screws). On playback, the head acts like a generator (coil-wound armature generating a little current everytime one of the little permanent magnets formed on the tape by the recording process, passes by). This is similar to passing a magnet through a wire loop attached to a galvanometer, as performed as an experiment in elementary science classes. The record/playback head is the loop (or loops) of wire with a metal core and the magnets are implanted in the magnetic brown coating on the tape, and the movement of the tape past the head, gives them the movement necessary to generate a small current through the (tape head) coil. This is amplified by transistor.

A little thought will show one that different patterns of rising and falling (lengths and strengths of the implanted magnets in the brown coating), of magnetism and therefore of the currents in the head can represent a lot of different types of waves from the complex waves of an opera singer to pure, single tones, to digital thumps. The audio recorder used with the Sinclair TS1000 and most other home computers is adapted to record sound waves and so the digital signals that the recorder wants to record onto the tape on saving a program are often sequences of tones (very short ones, of several cycles long). Different rates of recording and types of modulation and circuits in the computer to shape the signals to and from the recorder are used in different makes and models of home computers. The TS1000 uses a 300 baud data rate (300 bits of binary data per second). This is relatively slow as computers go, many using twice or three times that rate. This slow rate makes the time for recording a 16K program up to 6-7 minutes, depending on the format of the program. In addition to the program a header with the program name, computer version and so on is included at the beginning of the program saved on tape and before the actual program itself is saved. In addition the TS1000 will save nearly all of the system variables (like place of last PRINT AT command, column and row, RAMTOP value etc.) and the values of all the variables at the time of the program save (e.g. X=2.13 if that was the last assigned value of X on program execution). So the contents of a database may be saved on tape (just as it was inputted from the keyboard while the program was running), in string variables or numeric or string arrays. Of course if you execute a DIM A$ command the contents of the array A$(X) will be set all to empty arrays with blank spaces, or N(X) the numeric arrays set to zero. So you must not execute a DIM command unless you want to deliberately erase the data in the database once it is entered.

The cassette saving and recording is rather finnicky with the TS1000 as with most of the home computers of that time of design. It likes to save only on new, blank tapes. As well, the recorder must be clean and its azimuth well aligned and the electronic front-end in good working order. In addition some tapes especially ones sold with commercial programs on them made by a dubbing machine, will not work. If you put a cassette on top of the cassette recorder (and therefore near the speaker magnet in the recorder) can be enough to make it unreadable when you go to load the programs on it again. Same for the top of your t.v.. Any of these mistakes can be attributed to the demagnetizing qualities of magnets or heat. But there are cases where demagnetizing is used to good effect. Both the recorder heads and used tape that must be blanked for reuse, should be demagnetized. The tape head needs a head demagnetizer, the blank tape a bulk demagnetizer. You may even find that you may buy more than one cassette recorder over the life of your computer as your old ones suddenly go 'off adjustment' or optimum. Stereo recorders or microcassette recorders usually don't work. And when buying one make sure it has a mic jack! A tone control is good too (always set to the highest pitch). RFI is not a problem as it is with the Commodore datasette which must be placed at the full length of the cord to work reliably (that is farthest from the computer). Nor will a datasette work with the TS1000 or vice versa. Most cassettes will only load on the same make and model* as recorded on, with the TS1000, that is another TS1000, or ZX-81 or TS1500 only.

*computer, that is.

Repairing Cassette Recorders

When cassette recorders used with home computers stop working, the hardware hacker may think that there is nothing that can be done but buy a new one. Actually in some cases, fixing them is not too much for the handy, electronics hacker.

This of course assumes that you have eliminated all the other potential problems, and had the system working before it quit working. New users of cassette systems like the temperamental Radio Shack Model I, the cantankerous Sinclair ZX-81 and Timex 1000 and the RFI sensitive Commodore Datasette (which some say has to be placed the full length of its interface cord from the C-64), who are having problems maybe are best referred to the magazine and memory databanks of of veteran users at user groups. It may be merely a matter of finding the exact volume (and or tone) control settings. Other variables are the cassette itself (is it a fresh one, or has it been used before, a factor that in the ZX-81/TS1000 may make it unusable), and whether it has, once the recording has been made on it been placed on something hot (like the monitor/tv) or something magnetic (like the top of the cassette recorder itself, whose speaker has a powerful magnet in it, close enough to the external case to cause trouble). Alternately, the computer's circuits themselves may be damaged. Unplugging or plugging in the interface cable while the computer is trying to save or load a program, may ruin the part of the(MOSFET) static and spike sensitive integrated circuit(s) that are a part of most home computers and to which the cassette often directly connects! Assuming that none of these are problems and you have cleaned the heads with head cleaning fluid and a Q-Tip or some similar swab, and have demagnetized the head (Radio Shack #44-1165 is an example of one type of demagnetizer), then read on. (The other cassette problems have been covered well enough elsewhere.)

There are several symptoms of problems. One is lack of volume, particularly intermittently. The commonest cause for this and intermittent playback or recording (either) is the multi-contact, record/play switch. It is usually somewhere on the printed circuit board where a mechanical linkage can move a plastic (and square) contact rod inside a metal (tin-sheet metal) sleeve. This often gets dirty and represents the commonest problem with cassette recorders, of an electrical nature at least. It may be hard to restore proper contact however, the cleaning with solvents such as tuner cleaner, often having to be repeated and the manipulation of the rod, in and out, while spraying, tedious. Don't be surprised if the first attempt doesn't get it clean and restore the contact action to what it should be for trouble-free operation.

A second problem is that the input to the recorder from the mic.jack is damaged electronically. If it is an integrated circuit, forget it. Getting a replacement is probably not economical and will lead you on a wild goose chase through suppliers. But most have transistors here usually one or two small npn (TO-92) type ones that can easily be replaced by anyone who can replace such transistors in a t.v. repair or radio repair. Typically a 2N2222A or MPS-2222A or PN2222A or 2N4401 will do as a substitute. The faulty transistor may have leakage rather than straight failure and therefore may not be testable with a simple transistor testor (that is it will test good when it ain't). This transistor problem is the second choice, in the'pitch until you hit it'method of troubleshooting a cassette recorder with a volume problem.

Power supply problems (like low batteries of all things!) can also cause problems, and should be the first thing to check if you are running off batteries or an adapter (that perhaps has been left on too long?). Of course if the mechanism is jammed and will not wind or cause the tape to move during play or record you may well have a mechanical problem with the recorder (or maybe even just with a baulky cassette). Mechanical skills here with cleaning and lubrication can solve the problem. You may also mistake for a mechanical problem, which is eating tape (causing it to disappear into the inside and wrap around things), the fact that the little black rubber roller that pulls the tape through, is encrusted with enough brown tape coating to cause the tape to stick to it momentarily instead of coming off cleanly, and once getting loose, wrap around parts of the mechanism, the tape being that way, 'eaten' by the machine.

It is hoped that this list of a few of the common problems and fixes that the electronic technician can use, may help narrow the search for cassette recorder problems of the home computer user.

Memory Expansions For The ZX-81/TS1000

As the price of dynamic RAM memory came down, RAM pack expansions began to be more the rule than the exception for ZX-81/TS1000 owners. When an improved version of the TS1000 came out, it had 16K of RAM built-in, and this computer, the TS1500, in spite of a few ROM changes, runs ZX-81 programs.

The standard ZX-81/TS1000 comes with either 1K or 2K of internal RAM (actually DRAM, dynamic random access memory)for storing programs and variables and their contents. But the standard configuration of the computer has come to mean one with a 16K RAMPACK fitted which gives 16K of RAM storage. In addition the operating system and BASIC interpreter are contained internally in 8K of ROM (read only memory). This is where most people's experience ends although some have been serious enough in programming to insist on having larger memories added, either 32K or 64K.

With the 64K memory, you do not actually get to use all 64K since 8K where the ROM is addressed is not available. The result is a maximum of 56K of RAM. However when your BASIC program gets larger than 16K the whole system may crash unexpectedly. This is caused by the display file stradling the 32K point on the memory map. Enter LET ZERO=0+0+0+0+....to fix.* The memory beyond 32K is not wasted for it can hold variables especially the arrays used so frequently in filer or database programs, though only 32K of BASIC is program lines are allowed. To load a program of more than 16k requires RAMTOP be POKEd up to the higher value before loading, which one can forget.

One thing to remember is that if you are upgrading your system to 32K or 64K of RAM and/or adding a printer like the ZX-Printer, the computer will require a larger capacity power supply, one up to say a maximum of one amp. There are however CMOS memories (versus the standard NMOS DRAM's that don't require this extra power supply capacity).

There are several types of memory up-grade. The standard 16K memories by Timex or Sinclair and related earlier products are not stackable with each other. In other words you cannot use two 16K memories to get 32K. But the Memotec 16K and 32K memories are. By the use of a switch installed on the pack, you can use say a 16K Memotec memory with a 16K Timex one to get 32K. Another advantage of the Memotec memories is with a 64K memory by switching the external switch you can make it compatible (not interfering with) the ROM calls of the Larken Disk Operating System. With other makes such as the Gladstone 64K memory this is not possible and thus it can't be used with the Larken DOS accessory. Some disk systems such as the complicated and expensive Aerco system for the ZX-81/TS1000 have 64K built in on board the disk system board (which is bigger than the ZX-81/TS1000 mother board!) solving the memory problem.

With a memory larger than 16K you must NEW the computer and reset RAMTOP which is a bit of a nuisance if you have already loaded your program in before thinking of this. The procedure is (for the Gladstone) POKE 16389,255, POKE 16388,255, NEW and then you are ready to go. However there is the writer has heard a machine language routine that can be used to do this without NEWing the computer's current contents. See SyncWare News book, p. 74 for it.

There are several different designs of RAMPACK even for the Timex-made 16K ones but usually they use either eight 4116 or eight 4164 memory i.c. chips in black, 16-pin DIP packages as the chief components. If there is a error consistently in one memory spot (a single character in the program say always wrong) or garbage on the screen all the time it is probably one of these chips that is wrong. Replace them one-by-one (never resolder one as this results in higher risk of board damage). But of course first check the power supply voltage (when it is plugged into the computer) using a multmeter (9 volts is typical). Low voltage as well as bad cassette loads or bad cassette tapes (such as 120 minute cassettes which stretch!) can produce the same symptoms too. A simple check of the ZX-81/TS1000 edge connector contacts (and cleaning them with a soft art or pink eraser) and an inspection of the memory pack board for cracks or other physical damage is also a good first step, before getting into the heavier duty troubleshooting. Notice also that the memory chips are static sensitive and thus require special handling (even when plugged into the board) in order to avoid zapping them.

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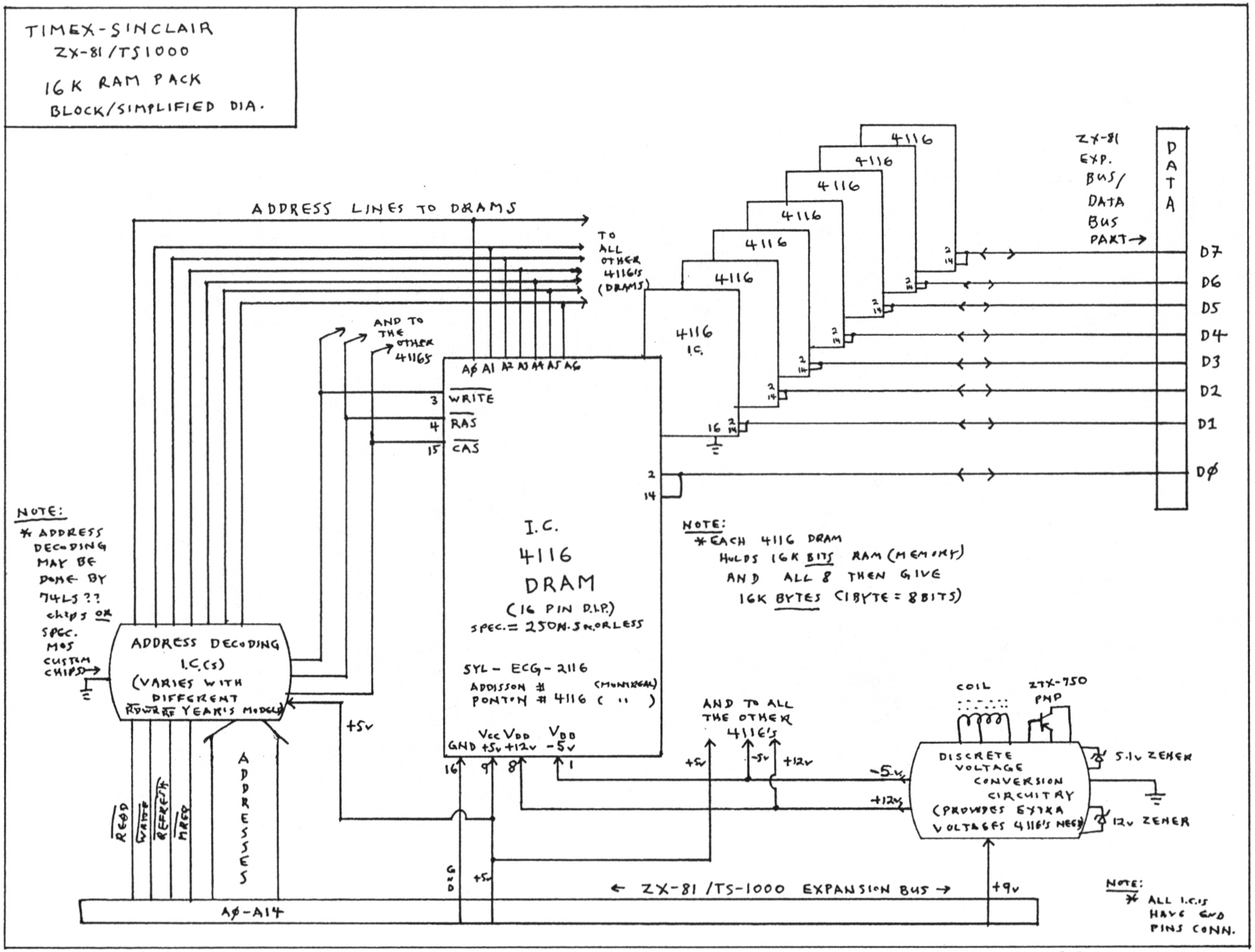
*Entering a large expression like this all at once when you are near the 32K memory map boundary will get you over it quickly. See next page.



TIMEX-SINCLAIR
ZX-81/TS1000
16K RAM PACK
BLOCK/SIMPLIFIED DIA.

NOTE:
* ADDRESS DECODING MAY BE DONE BY 74LS?? chips OR SPEC. MOS CUSTOM CHIPS

NOTE:
* EACH 4116 DRAM HOLDS 16K BITS RAM (MEMORY) AND ALL 8 THEN GIVE 16K BYTES (1BYTE = 8BITS)

NOTE:
* ALL I.C.'S HAVE GND PINS CONN.

1989 TS BULLETIN A.Pub.

Memories Other Than Timex-Sinclair And 32K and 64K

In the beginning, competing third party manufacturers made RAM packs of 16K for the ZX-81/TS1000. Some of them had a price advantage to the TS RAM packs. They were of various designs. The most successful of the accessory RAM pack makers moved on in time to larger capacity RAM packs like 32K or 64K. The 64K is actually a misnomer since the ZX-81/TS1000 will only handle 32K of program lines plus another 16K for variables/array contents (as you might expect a big database to have). So for BASIC programs, you need only worry about calling your expanded computer with a 64K RAM pack, a 48K computer. POKEd data of course can live elsewhere and so can buffers of various kinds. M/c can with 64K be at 8K-16K too.

To use the full capacity of your 32K or 64K RAMpack, you must do some programming of it at the start of the session. Otherwise it simply functions as a 16K RAMpack by default. You must*POKE RAMTOP with 192 for 32K and 255 for a 64 K RAM. The computer itself will set RAMTOP by testing memory to find the first memory address beyond the capacity of the fitted RAM. But since at the time of design of the ZX-81/TS1000, only 16K of RAM was forseen, it only checks up to 16K then sets it at decimal 32769 (or one plus128x256) for 16K or 1025 (one plus68x256) for a built-in 1K RAM (later ZX-81's and the TS1000's have 2K built-in RAM). The formula is one plus 16K (the ROM area of addresses including the 8K-16K reserved for ROM expansion once planned) plus the RAM size, 1K, 2K, 16K, 32K

RAMTOP is a system variable that determines (if more than 3¼K) use of full (or compact display file so less memory consuming),to reserve the little RAM space for programs), and the highest part of RAM that will be cleared by NEW (or RUN),as well as triggering the out-of-memory error (error 4/-).

* After the POKE, you must NEW the ZX-81/TS1000.

Electronic/Repair of RAM Packs

The first problem is getting in the case to see the insides and usually the case is fastened by hex machine screws. The size is not too easy to find unless with a full set of hex key sizes and is probably 2mm metric (which works) although a 5/64 th SAE/inch size will work too. Care must be taken in disassembly so that the innards are not zapped with static electricity since without noticing it, administering a little zap of static to the RAM chips may destroy one or more.

A typical schematic is given for the Sinclair/Timex 16K RAM pack, which may use either all TTL LS or some TTL LS and a custom PLA/ULA to decode the addresses. Expect to find the 6116 chips in the 16K RAM pack. A 32K memotex RAM pack contain eight 3732 chips while the Gladstone 64K uses 6164 chips. Decoding chips vary, 74LS00, 74LS14, 74LS157 having being seen in more than one design. Schematics exist for making your own RAM packs (as well as various other memory expansions) in the old copies of magazines (both Sinclair and electronics oriented) of the 1981-1985 period. Sometimes just a single cell (of a single DRAM) chip goes bad, producing an error when anything is saved in (say the program or its variables use that)area. Loss of a whole range or areas usually implies a decoding chip. Completely dead memory may mean something in the power supply (some have transistors, some coils that are fragile, some voltage regulators like 7805). Beyond that it is a job for the old-fashioned computer troubleshooting technician. Too many parts replaced may damage the board. However removing parts and replacing them with a socket (so that both a new and the old part may be tried), if you are meticulous with the soldering pencil iron (20-35 watt only), may solve the problem. The 74LSxx chips are not very static sensitive but the DRAM and custom decoders— PLA/ULA's are MOS and very static sensitive, especially in dry weather.

Using A 64K Memory Pack With Certain Conflicting Accessories

A 64K RAM has the full 64K of Z-80 accessible memory map used up. But the computer needs access to the ROM (0K-8K), so this part of the memory must be disconnected, internally by the RAM pack decoding circuitry. Some computer accessories like the Hunter Board, SCRAM board and disk systems like the Larken LDOS use parts of the 8K-16K in the memory map that was originally reserved for possible future RAM expansion. So, a modification to either the accessory or the memory pack pcb is required to avoid a conflict here. Again, many such modifications have been published in the extensive newsletter literature that may be accessible through a user group. Most of these problems can be avoided by switching the switch on the 64K Memotec RAM or just using a 32K pack instead of a 64K one.

Same Troubles And Fixes For Memory Failure

If the RAM chips in your ZX-81/TS1000 go (the 1K or 2K internal), as long as they don't absolutely short the power rails to ground, the computer will work if you plug a memory expansion (16K for example) on to the edge connector (end of the printed circuit board) at the back of the ZX-81/TS1000. Unless your machine has been custom modified to add the internal memory to the 16K or more of a RAM pack (plans for such a modification exist), the 16K RAM will replace the internal 1K or 2K of RAM as soon as you plug the 16K RAM pack on the back of your computer. You can even unsolder the RAM chips inside and (if you don't damage anything and just remove the chips), the ZX-81/TS1000 will work all the same. (The writer is indebted to Donald Lambert, for this last observation).

In **this book** (on p.15), is included a diagram for helping one to understand the 16K RAM pack. It usually uses the 6116,16Kx1 bit DRAM chips which are freely available at electronic and even surplus electronic suppliers for about $1-3. Few people however undertake to repair RAM packs since so many are available new or used, and just floating around user groups for about $5-20, it makes little sense to go to all the trouble. You must be careful not to subject the chips to static or to plug in or unplug the RAM pack from the computer when the computer power supply is plugged in. That may cause some chips to blow, either the DRAM chips themselves or the interface/memory decoding chips. In some models of 16K (by Sinclair or Timex) custom, programmed (PLA) chips are used in this function and needless to say would be just about impossible to obtain (from Timex or any Timex-Sinlair supplier). Earlier models use entirely TTL chips (74LS??) for decoding and these chips are easy to buy at any electronic supplier with a big enough stock. As long as the surplus RAM packs don't run out (and perhaps half-a-million or more were made), it makes little sense to try to repair broken ones. Failures include, one bad cell (one bad bit in 16Kx8 bits!), decoder failure, dead RAM unit and shorts possibly too.

Replacing the EPROM in the ZX-81/TS1000 main board that contains the operating system/BASIC interpreter, means that you must not only replace the EPROM but replace it with a properly programmed one. The one Sinclair uses is actually a true ROM rather than EPROM, simply because they are cheaper in quantity, but an EPROM can be used as a replacement (if you can get someone to copy the contents from a good ZX-81/TS1000 ROM, using an EPROM programmer), but some models of (vintages of) the ZX-81/TS1000 require some modification/handwiring to substitute an EPROM.

Replacing, repairing 32K or 64K RAM packs, may be more of a problem, as particularly the 32K ones may use hard-to-get DRAM chips and the supply of surplus 64K and 32K RAM packs and even used ones is a little more limited. You may have to hunt further afield to find a replacement. Some accessories don't mate with some 64K RAM packs, so using a 32K RAM pack may be the simplest way out of the problem. To mate for example a Larken LDOS interface for disk drives with a 64K Gladstone RAM Pack, you must make a hardware modification (to the LDOS interface board). The 64K Memotec RAM pack and 32K RAM packs work all right with it without any modification. And as for building your own 64K RAM pack from a schematic, the 64K RAM packs are often available for less than or about the same price as the 6164 DRAM chips (8 needed) themselves, that are used in most 64K RAM pack designs.

Plans also exist, now that we are into hardware hacking as a topic, to add RAM right inside the ZX-81/TS1000 case and as well to stack both Memotec 16K RAM packs (which are made to do so usually), and Timex-Sinclair 16K RAM packs (two giving 32K for example) if you modify the two Timex-Sinclair RAM packs. All these things have been covered in magazines or newsleters of user groups over the years.

For further reference, see p. 15 with the memory map/address chart, and p. 11, schematic (simplified) and block diagram for a typical 16K RAM pack. Since it is a simplified one for explanation and repair, it does not show all of the address decoding circuitry that one would need to build one from scratch.

Expanded Memory Accessories

The use of the 16K and 32K RAM pack memory expansions is relatively well charted ground, and even the 64K memories, though they tend to conflict with some accessories, are not beyond the average user. However, when you get into accessories which use an expanded memory facility, typically mapping their memory expansion into the 8K-16K part of the memory map left vacant by Sinclair, presumably for future ROM expansion, you get into the realm of the hardware hacker in some instances. EPROM modules, EPROM burners, battery-backed-up CMOS memory (in 1K blocks), the Larken LDOS disk interface board, the Hunter baord and its modified cousin the SCRAM board, all use memory in this area. In addition, you may wish to build from schematics or from an idea of your own, an accessory to go in this area of the memory map.

To focus on what we are talking about, it might be in order now, to take a glance at the next page, the memory map of the ZX-81/TS1000's 64K. You will see that the key to utilizing this area (at least in the 2K blocks of a 2K CMOS RAM, Static RAM or EPROM, you must design or have on the accessory or modify the accessory to, decode the high order five address lines and on achieving the right match, enable the 2K memory chip that you have there. It might be a 2K block of eprom (in a plug in cartridge or board that plugs into the expansion bus at the back of the computer, or a CMOS, battery-backed-up and thus non-volatile RAM (and so, a pseudo-ROM). A simple diagram for such an enable is given in the figure to the left of this text.

You simply wire a 5-input NAND gate to give an active low output to the chip enable if the right pattern on the address bus, has been set, by the Z-80, microprocessor. If high(logic one) is expected just connect that address line where it is expected to to one input of the NAND gate. If a low (logic zero) is expected, connect that address line to the input of an inverter (in say a 74LS04 or 74HCT04), and the output of the inverter to the input of the NAND gate. This will enable you to wire an address decoder, using the map on the next page, to enable a 2K EPROM or RAM chip.

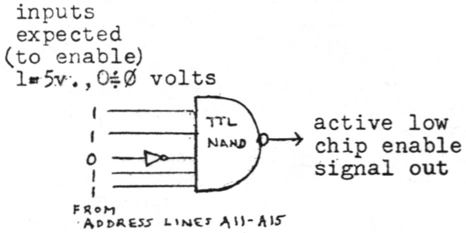


Fig.To Decode a 2K Block Memory
(In theory)

In the case of an existing accessory, a little modification may be required so that two defices do not conflict. The lower 11 address lines are connected straight through from the ZX-81/TS1000 expansion bus connector positions, to the memory chip's address lines (A0-A10).

This way, you can build a simple EPROM cartridge system using the 2K byte 2716 if you have EPROM programmer, already to program it, or a friend can program it for you. Similarly a battery-backed-up CMOS RAM or a SRAM can be placed in one of these 2K slots, between the 8K and 16K positions (before 16K!) in the ZX-81/TS1000 memory map.

A word about the PC8300 and like clones of the ZX-81/TS1000. They use their own RAM packs of 16K or 32K size. There seems to be a problem with mixing the ZX-81/TS1000 computers and RAM packs with the PC8300 computers and RAM packs, and it appears to be that some connections on the expansion bus of the ZX-81/TS1000 do not appear on the otherwise similar expansion bus of the PC8300. So, to interchange, these items, you may need to modify the PC8300 expansion bus by running extra lines (wire jumpers) directly between points on the PC8300 main board and the RAM module board.

You may have looked up the TTL book and found no specific i.c. for 5-INPUT NAND. The solution is to use 74LS30 or 74HCT30, 8-input NANDs with the extra 3 inputs tied to the +5 volt power supply with 3 separate 1K resistors. Wizards, at logic design will know that there are other ways of achieving the same thing, the way to choose, decided by the exact design and lowest cost, etc.

ZX-81 MASTER MEMORY MAP - RAM, ROM, CPU, Add-Ons

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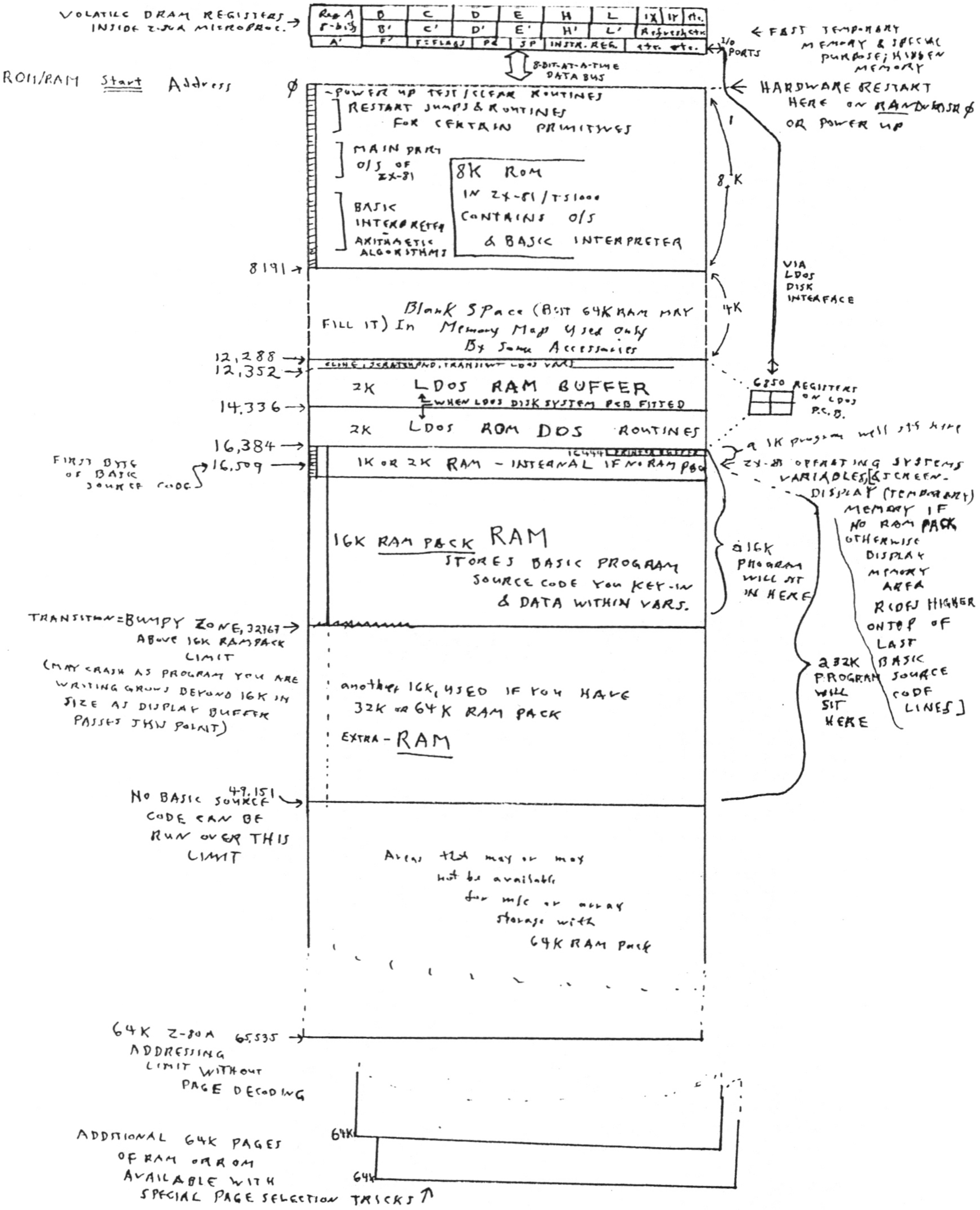
Timex-Sinclair ZX-81/TS1000 64K (& Beyond) Addressable


VOLATILE DRAM REGISTERS INSIDE Z-80A MICROPROC.
Reg A 8-bits
B
C
D
E
H
L
IX
IY
etc.
B'
C'
D'
E'
H'
L'
Refresh etc
A'
F'
F=FLAGS
PC
SP
INSTR. REG.
etc. etc.
I/O PORTS
← FAST TEMPORARY MEMORY & SPECIAL PURPOSE; HIDDEN MEMORY
8-BIT-AT-A-TIME DATA BUS
ROM/RAM Start Address
0
← HARDWARE RESTART HERE ON RAND USR 0 OR POWER UP
POWER UP TEST/CLEAR ROUTINES
RESTART JUMPS & ROUTINES FOR CERTAIN PRIMITIVES
MAIN PART O/S OF ZX-81
BASIC INTERPRETER ARITHMETIC ALGORITHMS
8K ROM IN ZX-81/TS1000 CONTAINS O/S & BASIC INTERPRETER
8K
8191
VIA LDOS DISK INTERFACE
Blank Space (But 64K RAM may fill it) In Memory Map used only By Some Accessories
4K
12,288
12,352
LINE, SCRATCHPAD, TRANSIENT LDOS VARS
2K LDOS RAM BUFFER
WHEN LDOS DISK SYSTEM PCB FITTED
6850 REGISTERS ON LDOS P.C.B.
14,336
2K LDOS ROM DOS ROUTINES
16,384
16444 PRINTER BUFFER
FIRST BYTE OF BASIC SOURCE CODE
16,509
1K OR 2K RAM - INTERNAL IF NO RAM PACK
a 1K program will sit here
ZX-81 OPERATING SYSTEMS VARIABLES [& SCREEN-DISPLAY (TEMPORARY) MEMORY IF NO RAM PACK OTHERWISE DISPLAY MEMORY AREA RIDES HIGHER ON TOP OF LAST BASIC SOURCE CODE LINES]
16K RAM PACK RAM
STORES BASIC PROGRAM SOURCE CODE YOU KEY-IN & DATA WITHIN VARS.
a 16K PROGRAM WILL SIT IN HERE
TRANSITION=BUMPY ZONE, 32767 ABOVE 16K RAMPACK LIMIT (MAY CRASH AS PROGRAM YOU ARE WRITING GROWS BEYOND 16K IN SIZE AS DISPLAY BUFFER PASSES THIS POINT)
another 16K, USED IF YOU HAVE 32K or 64K RAM PACK
EXTRA-RAM
a 32K PROGRAM WILL SIT HERE
49,151
NO BASIC SOURCE CODE CAN BE RUN OVER THIS LIMIT
Areas that may or may not be available for m/c or array storage with 64K RAM Pack
64K Z-80A ADDRESSING LIMIT WITHOUT PAGE DECODING
65,535
64K
64K
ADDITIONAL 64K PAGES OF RAM OR ROM AVAILABLE WITH SPECIAL PAGE SELECTION TRICKS

Accessory Keyboards

The plain, non-movable, membrane keyboard on the ZX-81/TS1000 is not quite as bad to use as many think. Since you have to press special key spots to get the tokenized BASIC functions in at all (LIST is only one key, you don't have the option of typing L-I-S-T) you won't touch type anyway.

Nonetheless, many accessory manufacturers made improved keyboards for the ZX-81/TS1000and you may indeed own one. However if you do not you still have the option (once the original membrane keyboard goes) of replacing it with another membrane keyboard (available perhaps still from Timex or Sinclair in the U.S. for about $6 (US$)) or making your own keyboard by adapting a surplus keyboard. Locally some have made keyboards from surplus Nabu computer keyboards (Nabu is a defunct teltext computer maker), and others have used surplus keyboards once intended for the TI-99A computer and available extensively mailorder (in Canada from Addison Electronics Ltd., 8018, 20e Avenue, Montreal, P.Q. H1Z 3S7).

The secret of using one of these keyboards is in keeping the wiring from the computer to the keyboard short (less than 10 inches). A ribbon cable with at least 13 connectors may be inserted right in the computer's connector (spreading the contacts so that the membrane keyboard can't be used again) or it may be soldered directly to the board. Another method uses a printed circuit board to solder the wires or ribbon cable to and then this etched board can be inserted into the connector with the copper fingers etched into both sides of the board providing the contact.

When you install another keyboard it is wise to take the computer right out of the case and build another case (out of wood, metal or fiberglass as your talents dictate) for it. At the same time a sturdier heat sink can be made (perhaps as with the Nabu right on the computer keyboard metal) for the 7805 voltage regulator on the ZX-81/TS1000 board and at the very least better ventilation provided since the overheating of this can cause problems.

Some people also connect an LED to the 5 volt output of the 7805 to act as a pilot light. The LED must be in series with a 330 ohm ½ watt resistor. The longer lead of the LED is the one to connect to the positive (non-ground) side of the 7805.

The original membrane keyboard will last much longer and be much easier to use if you are able to obtain an overlay for it such as the one made by Filesixty of London, England. A used computer fitted with one of these is much less likely to have keyboard failure than one that has not been fitted. This overlay simply goes over the original membrane keyboard and has small rubbery keys which offer much better feel than the original membrane alone.

To see how to wire up your accessory keyboard you only have to flip over the old membrane keyboard (which will peel off the plastic ZX-81/TS1000 case) and trace the conductive paths through the clear plastic back. Where the iring crosses under a key position when pressed is where you take the wires to the two sides of the keyboard switch. See also p.21, keyboard fixes.

Today few dabble in keyboard manufacture. In our Ottawa group, J.Mathewson made and sold accessory keyboards for both the ZX-81/TS1000 and the TS2068 (the latter with decoding electronics included). If you want a good keyboard for your ZX-81/TS1000, buying a surplus keyboard like the TI99 or Adam, etc. and wiring the key switches separately to a ribbon cable is the soultion if you are handy. If not seek a user group out for help.

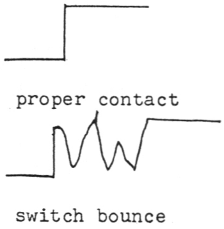
ZX-81/TS1000 RAM Pack-Wobble Fixes: A Note

One of the problems with the original design of the ZX-81/TS1000 was that the plans to brace the RAMPACK more firmly were abandoned before production in order to save on production costs. To solve this problem which can cause the computer to crash, many users have built their own brackets to join the RAMPACK and the computer. It is best to use a removeable system in case you have to change RAM packs should yours go bad or get into the computer if something else goes wrong with it. The Larken disk drive system solves the problem by connecting the RAM pack to the interface board rather than the main, keyboard unit of the computer so that disk users are okay. Another cure is lubrication of PCB contacts (only) with high viscosity mineral oil, suggested and used by TS users in Chicago workers at Motorola. Keep the oil off other parts than the contacts though.

Membrane Keyboard Problems

Of the common problems involving the ZX-81/TS1000, keyboard problems are the most frequent complaint. After about a year, if the keyboard has not been protected by the aftermarket, rubber overlay (sheet of buttons), it will usually cease working on all keys. That is, one or more keys (usually the enter key is the first to go since it gets more use) will no longer work unless you press really hard and since pressing hard is the usual cause of the problem, shortly after that these problem keys will not work at all.* Some keyboards in the ZX-81 kits don't work properly from the beginning. The TS2068 and QL which also use membrane keyboards have adopted the overlay fix which very greatly prolongs their life. The best solution for such problems is a new membrane keyboard (not available anymore to our knowledge) or a new accessory keyboard (ones made by wiring up a surplus/junk keyboard according to the pattern you can see and trace from the back of the old membrane keyboard). Wiring up a ribbon cable in the right fashion leaves you with a ribbon cable ending that when stripped back can be pushed into the old connector. Alternatively, a thin printed circuit board, etched with the appropriate fingers can be used to put into the connector and its fingers connected by soldering to the wires from the accessory keyboard.

This section will concern itself however with the simpler fixes for other keyboard problems. But first, it might be wise to mention, that there is a problem that is not easily fixed, and comes from the design of the computer itself. The ZX-81/TS1000 keyboard is not properly debounced. Fig. 1 shows the output of a debounced and a bounce-prone switch. This will give you an idea of what is being talked about. Bouncing means the momentary making and breaking of contact before the final, permanent, sound contact is made. Other than mercury switches, most mechanical switches have this problem. Digital circuits hate it however. The ZX-81/TS1000/TS1500, rather than using a proper hardware solution to the problem (like a latch circuit) use software in the ROM to debounce the switching of the keyboard contacts. The routine is a subroutine (CALLed by other m/c routines) at memory location 0F4B hex. The computer in effect samples the keyboard a number of times to make sure it has a real contact and not just a glitch being picked up. It is really only going to cause problems for the programmer (in BASIC anyway) who uses the INKEY$ command. The occasional wrong response will occur to this. The QL has been provided with an aftermarket i.c. to help with the debouncing problem with that computer. Fitting the ZX-81/TS1000 with debounce electronics has been tried but it is not for the unsophisticated.


proper contact

switch bounce

Fig. 1 - Debouncing

As for trying to fix a keyboard with one or more non-functional keys, one can only say that results vary widely as to success probably depending on the person's mechanical skills and dexterity in soldering and juggling tiny, frail pieces of wire and gluing/taping the result back together once you have got inside the little pocket in the membrane where the wires are.

The most common minor problem is getting the keyboard termination plastic out and then having problems. The first type of problem is from bending the plastic at too sharp an angle or scraping it, resulting in a break in the silk-screened conductive, silver coloured ink. The solution is perhaps painting over the break with that nickel or copper conductive paint sold in some electronic supply houses or even using special conductive epoxy glue.

The second type of problem is not being able to get the terminator back into the connector on the pcb. properly. Note that it must be in the proper position and making proper contact. Often after taking it off and putting it back one or more times, contact is no longer tight. Various quick fixes have been tried such as using carboard or paper or thin plastic strips to push the conductive surface more tightly against the contact (wedging in thin business card thickness cardboard on the side away from the contacts). The best solution is not to get to the point where you have this problem by trying to do repairs/modifications inside the ZX-81/TS1000 without removing or bending too much the keyboard terminator tab of the membrane.

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* Although they may work again, after a fairly long rest.

Accessory Conflict Problems

Sometimes you might find as you add accessories to your system that all of a sudden it ceases working or more likely ceases working on one type of job or program or intermittently. In expanding your system you may have inadvertently combined two accessories that are not compatible. They may try to use the same memory for different things or use conflicting timing or ports. But the simplest problem, and the easiest to fix, is simply putting too many accessories on a small, unupgraded power supply. Most accessories demand an upgrade of the power supply to a higher capacity one and you may not sense this. Some even have their own power supply but still require the computer's power supply to be upgraded too (like a disk drive that uses a longer bus expansion via a ribbon cable, and more gates to drive at their terminations). Other than disk drives, the ZX-Printer (not the Alphacom 32 or TS2040) is probably the most power hungry device. RAM packs above 16K also have a thirst for power, 32K a fair amount and 64K more still.

The way that memory is mapped in the ZX-81/TS1000 is a bit peculiar in that at its original design, large memory expansions had not been forseen and in the early days there was even some doubt that a RAM pack larger than 16K could be designed* that would mate with the ZX-81/TS1000. It still does mean that you can only use 32K of RAM for your programs (on arrangements that are not special) written in BASIC and the higher memory (about 8K more) can only be used for for data, array contents, variable values, even with a 64K RAM pack. Of course there are exceptions, and special techniques, and machine language programs, and CMOS memory that uses the 8K-16K of the memory map (like the Hunter and SCRAM boards), but these are more exotic applications. Even to use the 32K of RAM you must raise RAMTOP (say by POKE 16389,192 and then doing a NEW on the computer before loading a long program that will use this extra memory). There is another trick in that if the display file straddles the 32K part of the memory map (which occurs when your program gets longer than 16K), the whole computer will crash and all your program will be lost. To solve this, test as you add to your program with a PRINT PEEK 16401 * 256 + PEEK 16400, to see when this gets very close to 32767. When it does enter an almost full screen statement LET ZERO=0 + 0 +0 + ... up to more than 100 repetitions of the ...+0... so that this will take you in one leap over this 32K borderline in the memory map. Once you are well by it (have added more than 1 or 2K to your program, you can delete it).

The more fundamental hardware conflicts involving RAM packs include that the Gladstone 64K pack is not compatible with the Larken LDOS disk drive system. However the later Memopak 64K ones (and the 32K ones) are. The Memotec ones have a switch on the 64K one that can be switched to solve this problem. A hardware modification can be made however so that you can use the Gladstone 64K and your Larken LDOS disk drive system if you are into hardware hacking. This is one incompatibility that the writer knows about involving RAM packs but there are probably many more.

When Sinclair designed the TS1000/ZX-81 the area from 8K to 16K on the memory map was left vacant, presumably for expansions to the ROM (0K to 8K) that were never required. The ZX-80 for example had a 4K ROM and this was expanded to the ZX-81's 8K ROM, making the BASIC floating point rather than integer, into the bargain. Now, some devices use the 8K to 16K area and it is possible that two incompatible devices will use the same parts of it for different uses, therefore interfering with each other when they are both hitched up to the ZX-81/TS1000. To see if this could be a problem, read the manuals that came with the accessories and try unplugging all the accessories and try different combinations of them, testing to see when the problem reoccurs, so that you know which two accessories are in conflict. Some user groups have people who know of hardware fixes for some of these incompatibility problems, so you may be able to find a fix there, perhaps from an old newsletter in their files.

The simplest solution however is to get two ZX-81's or TS1000's and hook one system with one device of the two that conflict and the other with the other conflicting device, through that avoiding not being able to use one at all. If that is possible, at the price of the ZX-81/TS1000, why not?

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Power Supply Related Problems

Any computer can crash (lock up, cease working) when a voltage spike on the line or brown-out occurs, and the ZX-81/TS1000 certainly will too. These problems may come from outside the house or appliance motors turning on or off inside the house. Unlike the other problems below, they are fleeting.

One of the most frequent causes of difficulties and crashes with the ZX-81/TS1000 and its attached accessories is a fixable power supply defect.

Examples:
- computer running too hot (due to hot weather/climate)
- loose fit of jack in side of computer for power supply
- too many or too high current drawing accessories attached to the power supply
- intermittent, no or low voltage output of external power supply, due to intermittent transformer inside it
- intermittent or total failure of 7805 voltage regulator inside computer's case
- crash caused by shutdown of 7805 voltage regulator on a hot day or after long use by automatic thermal shutdown feature triggered to prevent damage to 7805
- power supply shorted or pulled down in voltage by dropping part or junk into open circuit board or case or by a leaky filter capacitor in homemade power supply or a leaky transient suppressor in homemade filter
- external power line dip from furnace/air conditioner motor

The 2nd problem is common when operating any memory expansion above 16K DRAM and/or a ZX-Printer or anything else drawing current from the computer's supply. The standard power supply supplied by Sinclair was usually a 9.75 volt, 650 ma. one. Adding a larger memory might require at least 750 ma. and a printer and memory 1 amp or more. Luckily you can make your own power supply as a hobby project(using one or more 7810 voltage regulators and a 12v a.c. secondary transformer) if you are handy at electronic design and construction. This will save on having to look all over town for someone who has the proper one in stock.

Checking the power supply voltage:- It usually measures 12volt d.c. if it is not plugged into the computer but closer to 9 volts when it is driving the computer (under load that is called). Note that the performance of the computer may seem to be okay but instead it may seem that there is something wrong with the cassette or disk drive or printer or television display strength when either the voltage of the power supply unit is too low or the supply cuts out say after it has been running for a while. This is not to be confused with the TS2068 problems which are a natural feature of the machine where some problems particularly in loading baulky programs from cassette or ZX-81 cassette programs through an uploading program can be cured by simply letting the computer cool of for a couple of hours and trying it again. Symptoms of low or cutting out of voltage of ZX-81/TS1000 can include garbage on the screen, cassettes that will not load (saved at low voltage), good cassettes not loading, diskettes destroyed and CRC errors when using a disk drive, and weak video on television display.

Anyway, don't throw away the computer in these cases. Even replacing the 7805 inside the computer is not a hard job for someone handy with a pencil soldering iron. The 7805 can be bought at Radio Shack or nearly any other electronic parts store. Note: a 7905 will not work;78M05 will not work.

Don't leave your computer on for days in hot weather or without proper heat dissipation. Some leave the computer on permanently but this may not work for everyone, particularly in the hot weather. Doing this can destroy the internal 7805, the external power supply unit, or both.

The simplest method of troubleshooting is to substitute a good external power supply unit (maybe a friend's one) and then go from there if that does not solve the problem to measuring voltages etc. Note that the computer needs both 9-12 volts and 5 volts internally as well as some negative supplies for the memory integrated circuits (4116's) in the RAM Packs which are generated by special coil circuits inside the RAM pack case.

Parts Substitution List For ZX-81/TS1000

Resistors-all resistors are standard ½ or ¼ watt

Except:-RP-3, a 6-pin, five 10K resistor pack in a SIP package
(in a pich this resistor array could be replaced by
five ¼ watt resistors wired up by hand according to the
schematic)

Transistor -ZTX-313 may be replaced by MPS-2222A, PN2222A, 2N4401,
ECG-123AP, or Radio Shack #276-2009

Voltage Regulator i.c. (5 volt output)-1 to 1½ amp, 3-pin, TO-220
replace with 7805 generic i.c. (not 7905 or 78M05 !!)
Radio Shack #276-1770, ECG-960, ua7085 (Fairchild), MC7805CT (or ACT)
Silicon Diodes - 1N4148 or 1N914 are suitable replacements for those
on the main board (not power supply diodes)

Microprocessor -Z-80A may be replaced by Z-80A, Z-80A-CPU, Z-80B, Z-80C,
or even Z-80H (but not by Z-80) (40-pin i.c. 3)

On-Board (Main Board) RAM-replaceable by DRAM 4118 or if two chips,
two 2114 (this is for the 1K versions)
-4816 is the replacement for 2K models
(for replacement of 4118 by 2114 models, see schematic for
instructions on wiring up pins)

i.c. 2, is Sinclair ROM, a custom chip that must be replaced by a similarly
programmed chip from Sinclair or Timex (It is loaded with the operating system and BASIC interpreter, machine language programs)

i.c. 1, is Sinclair custom chip specially programmed* by Sinclair and must
be replaced by a similarly programmed chip from Sinclair or Timex
(it is called a U.L.A. or SCL (Sinclair Computer Logic) chip).
* blank/ zombie, useless without programming, by Ferranti

Parts of Timex 1016 -16K RAM Pack -Typical

Note: parts vary, earlier ones not using ULA, but other mfgrs. vary
even more than Sinclair/ Timex original parts

i.c. -ULA 1H035 -programmed by Timex, blank/ zombie* by Ferranti (* useless)
-74LS157
-8 x 250ns or less, 4116 which needs + 5v., +12v., -5 v. p.s.u.
--custom coil, 45 turns, 5turns, tapped once, fine wire, small ferrite
coil core/ form, to provide -5 v., ZTX-750, pnp transistor, 5.1v,
& 12 v.zeners

Parts of PC8300 - A ZX-81/TS1000 Clone - See p.A-2

-incl.parts for separate 16K RAM pack, 32K RAM pack also made for this model
i.c. - Z-80A Microprocessor -9.2v, ½ watt zener diode sound.cir.
-C4005 -MOSFET ULA -1N4148 diodes, glass, Si
-8440 ROM -6.5 MHz.ceramic resonator/ 3 leg.
- 2016 DRAM -1402C NPN transistors=2N4401, 2SD227
- 74LS05, 7805 voltage regulator, 12-14 a.c. volt wall p.s.u., 16v.ct A.C.
16K RAM pack: -2 x 74LS157, 74LS00, 74LS32, 8x 8445/ 8347 DRAM's, 5.2 v. zener
different character set/ code, ROM routines, & no A15 on slot
connector of RAM pack, DB8 joystic conn., sound/ spkr.

Printed Circuit Board Testing, Repair and Hacking

On using a test meter on the p.c.b. of the ZX-81/TS1000,at specific points, one soon finds out that the board itself and its conductor traces have been coated by a protective, plastic material. To make a true test one must test on a lead or pin of a component where it comes out of this coating. In soldering in a wire (where a trace is open or damaged, in place of a trace of foil conductor) this must be scraped off by a pen knife before you can get any solder etc. to stick. In repairing a finger on the back external bus connector, any trace (copper strip or even a thin bit of flat solder braid) that you are replacing, must be epoxied to the board, although it is preferrable if it need only be repaired by coating the damag- finger with solder. A troublesome item for the ZX-81/TS1000 is the plastic ribbon that comes as part of the membrane keyboard, and which must be inserted into a connector. Often the connector pins get weak with repeated insertions and removals and different fixes such as paper wedges have been tried. If the conductive paint on the plastic strip should crack, copper and nickel conductive repair paints are available at many electronic parts stores. As a last resort, you might try wire. The best solution is to replace the membrane keyboard (which has a tendancy to go after a year of constant use) with a proper one, terminating in a ribbon cable that may be inserted into the connector on the ZX-81/TS1000 board. Other mechanical problems include those with the flimsy jacks for power supply, tape MIC and EAR. The prongs may simply require being gently and carefully bent back into position in order to make firmer contact with the plug inserted. Loose phono plugs where the video/t.v. goes out (especially loose inside plug/shaft contact) have also been noted, and perhaps soldering is the ultimate solution for that malady (other than fiddling). This problem can also be simulated by (but not caused by) a loose or dirty channel control on your t.v. (if v.h.f. channel used by the ZX-81/TS1000). A tuner cleaning (which requires the back to be taken off the t.v. and the cover metal over the tuner, is probably best left to someone familiar with t.v. repair. (It is a myth that tuners can be cleaned by squirting tuner cleaner in beside the knob from the front. Some disassembly is required.and must be done properly.)

Board Hacking

Aftermarket hacking of the ZX-81/TS1000 board is not that unusual for the plans published in user group newsletters for modification. Even installing an improved eprom instead of the ROM may require a little hacking.* Plans also exist for installing various kinds of memory inside the case of the computer or even connecting the 1K ir 2K that is there so that it adds to the 16K in your RAM pack, rather than being replaced by it. (* depending on the vintage of ZX-81/TS1000 board.)

Board modification after the fact is not all that funny a practice since many manufacturers (including major t.v. manufacturers like Hitachi) do it anyway to fix problems in the design of their boards that only become apparent later, after a lot of them have already been manufactured. Placing a resistor in, where one has left no trace whole to place one, can often be done by soldering it in to a part of the board (cleaned off, if necessary of that insulating coating)and may not even require a piece of wire to lengthen the leads. Sometimes a Y-circuit is used with two resistors and a capacitor. Again, not too complicated, but the whole thing or at least the bare leads in these two cases should be covered by insulating tubes (spaghetti, as its called in the trade, or unshrunk, heatshrink tubing perhaps for a larger diameter tube). The main consern is that the leads not be squashed when the whole thing is used or out in the case again, shorting out some other part of the circuit. That is the main thing to be wary of other than sloppy soldering.

When you have to replace or test by substitution an i.c. that is not socketed, unsoldering it, one pin at a time with solder braid, and replacing it with a DIP socket, so that you may retest the original component as well as its new replacement part, will save time in toubleshooting.

Getting a whole board inside your computer, may be less of a problem if you use up-to-date, surface mount technology. The sort of transistor circuits using 2N3904 or 2N3906 transistors can be done too, very small and therefore possibly easy to fit in a case with the rest of the computer. Also standard i.c.'s like 74LSxx, 74HCxx, 40xx (CMOS), 555, CMOS 555, 741 and 324 are avaialble from the right sources in small surface mount packages, about half the size and quite a bit thinner than their corresponding d.i.p. versions. 'Electrickery'like using a spare op amp as a gate, a transistor or two as a gate or inverter and a CMOS i.c. (digital) as a linear amplifier, can be found in circuit libraries in magazines for the electronics hobby.

The ZX-81/TS1000 As A Hardware Hacker's Controller To Interface

The ZX-81/TS1000 is the best vehicle for hardware hackers to do microprocessor projects with since all the hard work (connecting ROM,RAM and taking out address and data lines to connect them and a bus together) is already done, all the things like built-in BASIC (and Z-80 assemblers), keyboard, screen interface are provided and you don't feel like you are risking a whole lot of dough if you blow it up ($35 or so won't cause as much consternation as blowing up the family Macintosh or PC AT).

In its heyday, boards were sold to expand the bus into project PCB's but it is easy if you are handy to make your own connector for the back slot with a 50 connector female edge connecting socket and a 50 wire ribbon cable, (with extra wires snipped off each end and two connectors positions hacksawed off each end of the connector, using crazy glue to glue the connector back together once the ribbon is inserted). Once you have such a connector at one end of the ribbon cable, the wires can be separated and stripped and pushed into (as needed) the positions on say a Radio Shack, #276-174 modular breadboard socket. The circuit you are experimenting with can be built up on this board using jumpers of wire, resistors, etc. and the integrated circuits can be plugged in too (the spacing is as for 1/10" DIP pins). Such a socket has almost 50 lateral connections and of course extra sockets boards can be added to your project. If you want to save the device you have built, the matching p.c.b. #276-170 will enable you to copy the same circuit and solder in the components this time.

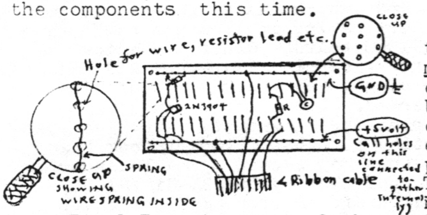
CLOSE UP
Hole for wire, resistor lead etc.
GND
2N3904
R
+5volt
(all holes on this line connected together internally)
SPRING
CLOSE UP SHOWING WIRESPRING INSIDE
← Ribbon cable

Fig.1-Experimentor's Socket #276-174

Those who want to run multiple boards off the ZX-81/TS1000, may build a motherboard arrangement in which a p.c.b. with straight traces of conductors (lines) wire up any sort of plug in board to female connectors. Any sort of card could be wired up this way theoretically given enough thought and some interface electronics perhaps between the ribbon cable to the ZX-81/TS1000 and the motherboard. So, the motherboard need not be simply an extension of the ZX-81/TS1000 bus!

At the right a little drawing of a simple bus extender arrangement with one board out of the four slots in use. The ribbon cable at the left of the diagram goes to the ZX-81/TS1000 back expansion bus slot.

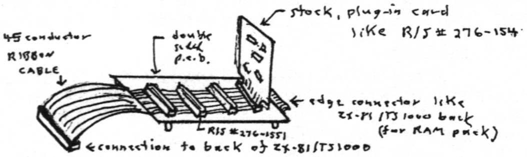
stock, plug-in card like R/S # 276-154
45 conductor RIBBON CABLE
double sided p.c.b.
← edge connector like ZX-81/TS1000 back (for RAM pack)
R/S #276-1551
← connection to back of ZX-81/TS1000

Fig. 2 - Motherboard-Bus Extender

If you are thinking that someone ought to have written a book on this you are right. Not only at least one book, but many magazine articles have appeared in the heyday of the ZX-81/TS1000 both in Sinclair and electronics hobby magazines, 1981-1985 approximately and many articles still appear in user group newsletters. One book that may turn up somewhere is,"Timex-Sinclair Interfacing" a book of tested projects for serial and parallel interfacing and using the ZX-81/TS1000 for digital/analogue, printer, RAM expansion or dumb terminal uses as well as a lot of practical and theory tips, and the book is by J.M. Downey & D. Rindsberg, Prentice-Hall, 1983 (paperback). Popular Electronics and Radio-Electronics also published years ago, projects for the ZX-81/TS1000 hardware hacker. Some Sinclair magazines and a lot of newsletters also published hardware projects. A good source for these latter would be the library of your Timex-Sinclair User Group, or even the Sinclair magazine collection of members who have moved on from the ZX-81/TS1000 to the TS2068 or QL. Incidently, the TS2068 has a back expansion slot with the same pattern of connections as the ZX-81/TS1000, although the two computers do not share the same architecture and software in ROM (or memory map), so that only some ZX-81/TS1000 interface projects could be adapted to run on them.

So many accessories have been made at one time, commercially or home-made (or both) for the ZX-81/TS1000, from EPROM programmers to burglar alarms/monitors, epanded memory to all sorts of bus interfaces (RS-232, Centronics printer, lightpen, joy-stick, expanded keyboard, etc.) that there are lots of experiments possible.

List of Accessories For The ZX-81/TS1000 Which May Be Seen On Used Market

(Altho Many Available New Too)

Other Languages -Software

MCODER, and MCODER II (BASIC compilers, integer only), Tiny LOGO, Partial Pascal (Integer Pascal, allows however decimal fraction factors/constants), FORTH (by a number of makers including ZX-FORTH by Artic, PluriForth cartridge, a partially BASIC interpreter FORTH, ...)
RPNZL (a Forth like language using Reverse Polish Notation), Extended BASIC (Thos. Woods), High-Res BASIC (Silicon Mtn.),

Assembly Language/Machine Language (Z-80 Microprocessor)

-Hot-Z (assembler, disassembler, debugger), ZX-Assembler (by Artic), ZX-Bug (machine code monitor and disassembler)

General Purpose Programs

-Vu-Calc (spreadsheet), Vu-File (also called The Organizer)-file card database,

Operating Systems -Nova 1000 (multitaking/time slicing), CP/M was planned as part of the Aerco disk drive system but never was completed and sold, OS-64 (64 column display system)
Faster Loading/Saving -Fastload (software and hardware device required), Turnbull Fastload (machine code program, available Ottawa/Hull TSUG)

Word Processors/Text Editors
Masterscribe (E.Arth. Brown Co.), Tasword,

Disk Drive Systems -Larken System, Aerco System, Oliger System

Other Storage Techniques -Wafa drive, Microdrive, Wafer Drive, EPROM cartridge system (makes EPROMS and allows them to be used like cartridges), Hunter Board, SCRAM Board (the latter two use the 8-16K area as static ROM-like storage), 1 and 2K CMOS static storage boards,

RAM Packs -16K,32K Memotec (can be stacked to give say two 16K for 32K), 64K Memotec, 64K Gladstone, 16K Timex, assorted 16K, 32K and 64K of various mfg -bank switching RAM systems allowing more than 64K, (Note*that 32K is the largest BASIC program (not including array storage areas) that can easily and foolproof manner be used in ZX-81/TS1000)-RAM packs larger than 16K may require more heavy duty power supplies than the standard Timex 650 ma. model

Printers -ZX-Printer (silver paper), TS2040, Alphacom-32 (use white paper), although the paper used by these printers is only like adding machine paper in width. Full size printers can be added with Centronics Interface (Aerco, Memotec etc. although problems may develop as far as compatibility with individual makes of printers) -printer driver programs may also be needed with the big printers as well as a lot of fiddling/troubleshooting to get working

Most Useful Books-Mastering YourTimex Sinclair Personal Computer -Hartnell & Jones (Bantam), The Essential Guide to Timex/Sinclair Home Computers(S&Shustr

The ZX-81/TS1000 BASIC Commands And Why They Are Different

Saying that the TS1000/ZX-81 BASIC is different is just stating the particular case of a general rule, the BASIC's of different makes of computer and even different models do vary in what they allow and how they allow a BASIC command to be stated. Why not standardization at the start? Well, BASIC kept growing and improving over the years since it was invented by Dartmouth Professor Kemeny and every new computer made was an irressitible temptation to introduce differences thought of (and which often were) improvements at the time. TS1000/ZX-81 BASIC is one of the better and easier to use BASIC's and at the same time a well thought out dialect.

Short List of Variations

TS1000 BASIC won't allow 100 A=7 but only 100 LET A=7 -- you need the LET

It won't tolerate IF A=1 THEN 1000 but needs ...THEN GOTO 1000 -- you need the GOTO after THEN if you want it -- you could do THEN PRINT or THEN LET A=10 or THEN GOSUB 500.

It doesn't have the symbols: #, %, &, © nor allow the special things that they stand for in some languages, nor nor ↑ although you can substitute for the latter two - and ** (for raise to a power).

It doesn't have ASC( ) but then since this stands for'ASCII code of' and the computer uses its own peculiar code, there was no sense in calling the equivalent command ASC and instead it is called CODE ( ).

PAUSE is a sort of timer, instead of LOCATE you can use PRINT AT X,Y; then PRINT for most uses --unlike the Commodore 64 it has CLS (clear screen) and instead of PRINT © you use PRINT AT x,y;"WHAT YOU WANT"

It doesn't have lower case letters (small letters like this) just CAPITALS LIKE THIS. It does however have inverted letters (white on black).

It doesn't have LEFT$, MID$, or RIGHT$ but then they are confusing anyway. Like the Atari 65XE,130XE it uses string slicing to do the same sort of work. Example: MID$(S$,3,2) is done, S$(3 TO (3+2-1)), MID$(X$,Y,1) is X$(Y), RIGHT$(S$,7) is S$((LEN S$)-7+1)TO LEN S$), LEFT$(X$,2) is X$(1 TO 2)

It doesn't have READ or DATA statements but then it can do much the same sort of tasks as these do without them (by GOSUBs for example).

DRAW and CIRCLE, LINE etc. it does not have. PRINT and graphic characters or PLOT and UNPLOT may help you do many of these things in a different way with a few more lines and some borrowed (or home-made routines).

SCROLL is used because it doesn't have automatic scrolling like say the Commodore computers. SCROLL moves the screen dsiplay up one line and that is all. It doesn't turn on a scrolling feature for automatic scrolling.

FAST and SLOW - well just try them and see. (Try them as immediate commands before you run a given short program). The one cancells the other, in changing between SLOW and FAST mode of display, etc. operation.

DIM A$(10,12) - two numbers but one dimension string array. The second number is the number of characters that each array element will have. The ~~fir~~ first number is the number of elements in the array. For a three dimensional string array use three numbers, the third giving the maximum/fixed number of characters in the string. But watch it! This command is a memory hog! It doesn't take very high numbers on this to fill your RAM up and give you an error 4/- message, out-of-memory.

The Simplest Alphabetic Sort - The Bubble Sort

The following routine will sort alphabetically the string array elements A$(1), A$(2), A$(3).... It will also sort an array of numbers, A(1), A(2) etc. in order from smallest to highest value, if A(X) etc. is substituted for A$(X) etc. This assumes that the BASIC of your computer will compare alphabetical strings which most do but a few older models may not. Some integer compilers or integer BASIC's in particular may lack the ability to compare strings to test for alphabetical order. However most home computers including the Radio Shack Color Computer, MC-10, Timex-Sinclair ZX-81, TS1000, TS1500, TS2068, IBM PC (BASICA or GW BASIC) will work with alphabetical sorting like this I'd guess. Some computers will not accept line 160 but will accept it if you just delete the GOTO (example TI-99/4A). Many computers (IBM PC etc.) will accept it with either the GOTO left in or taken out. With some computers the LET can just be left out and possibly a few need to have the LET left out. In that case just delete them, leaving say a LET E$=A$(X) just as E$=A$(X). Of course in the alphabetical sort mode E$ is used in lines 170 &190, in the numbers sort it will become just E. As well, some computers like the Timex-Sinclair ZX-81/TS1000 will profit by increasing the speed of execution by putting in as line 130 FAST and as line 220 SLOW. The fast mode blanks the screen while such a routine is running removing the burden of the task of printing/writing to screen while doing it and allowing the computer thus to concentrate all its energies on the sorting. The Commodore 64 requires a POKE to do this and the result is not as dramatic in speeding things up. POKE 53265,PEEK(53265)AND 239 will call the FAST mode and POKE 53265,PEEK(53265)OR16 will return to SLOW mode. The bubble sort given below is also called in some texts the substitution sort.

```
100 REM ARRAY BUBBLE SORT - ALPHABETICAL ORDERING
110 REM THE DATA ITEMS ARE FIRST ENTERED INTO ARRAY A$(X)
        STARTING WITH ITEM A$(10), THE LOWER ARRAY ELEMENTS
        MUST BE LEFT EMPTY FOR THE TEMPORARY JUGGLING OF
        THIS ROUTINE, SO USE DIM A$(110) or in some comput-
        ers DIM A$(110, 20) say where 20 is the number of
        letters allowed in the string array word, AND THE
        MAXIMUM NUMBER OF ELEMENTS WILL BE 101
120 LET END=100
140 FOR X=10 TO END + 9
150 FOR N=X + 1 TO END + 10
160 IF A$(X)<A$(N) THEN GOTO 200
170 LET E$=A$(X)
180 LET A$(X)=A$(N)
190 LET A$(N)=E$
200 NEXT N
210 NEXT X
230 STOP
```

Note that the routine will run faster (and some computers will require it) if you put in an actual number in lines 150 and 160 instead of END +9 and END +10. Similarly a line 145 LET Y=X+1 and changing 150 to FOR N=Y TO (followed by a single number, whatever END which is 100{for 101 elements of the array} plus 10 amounts to). Only rather early home computers or some compilers will demand this.

A routine to fill the array (input to it) might go like :

```
20  FOR X=10 TO 110
30  INPUT A$(X)
40  NEXT X
```

(Note: the array must be DIMmed first, before doing this).

Sorting routines are the building blocks of even the simplest database, file card, and mail label producing programs. Surely, at least one should be in your library of subroutines.

Writing Database Programs for The TS1000

It is not too hard to write a database program for the TS1000 home computer once you understand the way that databases work. The elements of a database program are:

1. Blocks or lines of data (each item has a record which may be further broken down into fields, like name (20 spaces, address 30 spaces, tel. no. 10 spaces)
2. An editor program to input and/or edit the data you wish to key-in to the blocks of data.
3. An output program to list or display on the screen the data.
4. A sort program to sort the data (say in alphabetical order by name)
5. Optionally a search program to find a given item, like the files of people whose names begin with 'B' like BROWN.
6. A print-out program to print the data out on the printer (such as a ZX-Printer or TS2040 printer to mention the two most common thermal printers. for the TS1000.

To set up the blocks of data you must have a dimension statment, such as for a 64 space record as in the above example, DIM A$(20,64) to set up 20 records (for 20 different people), each with 64 spaces. This will use at least 20 times 64 or 1,280 bytes of your 16K available (if you are using the 16K RAM pack). The program must fit in the rest of the space. It may be entered as:

```
9989 STOP
9990 DIM A$(20,64)
9995 REM set up array for data
9999 STOP
```

Do a RUN 9990. Now the arrays are set up. Executing that DIM statement again must be avoided as long as you want to keep the dta since running it will erase the data in it!

To input the data the simplest possible program module would be:

```
700 FOR X=1 TO 20
710 INPUT I$
720 IF I$="EXIT THEN GOTO 790
730 IF I$="" THEN GOTO 780
740 LET A$(X)=I$
780 NEXT X
790 REM GO BACK TO MENU
795 GOTO 100
```

Of course this simply allows you to input two lines (64 characters including spaces of undifferentiated data. A more eleaborate way would be to enter name etc. address and telephone number all separately.

```
700 FOR X=1 TO 20
710 PRINT "ENTER NAME"
720 INPUT N$
730 LET A$(X)(1 TO 20)=N$
740 PRINT "ENTER ADDRESS"
750 INPUT D$
760 LET A$(X)(21 TO 50)
770 PRINT "ENTER TELEPHONE NUMBER"
775 INPUT T$
776 LET A$(X)(51 TO 60)=T$
780 NEXT X
```

Writing - Databases (Cont.)

Of course much more elaborate and detailed modules could be written combining the editing features of the first module with the field by field input of the second module. If you don't type in exactly the number of spaces in the fields in the second case too, you may need some editing routines like:

```
720 INPUT N$
721 IF N$="" THEN GOTO 740
722 IF LEN N$< 20 THEN LET N$=N$+ "    (20 spaces)    "
723 IF N$>20 THEN LET N$=N$(1 TO 20)
724 IF CODE(N$(20 to 20))<38 THEN GOTO 720
725 REM THIS ELIMINATES A NAME STARTING WITH A NUMBER, SPACE,
       OR OTHER ODD CHARACTER THAT A NAME SHOULDN't START
       WITH
730 LET A$(X)(1 TO 20)=N$
```

The sophistication of your editing routine and its 'bug traps', little ways of stopping potential bugs before they get started is unlimited. For example the bug trap in line 724 above will prevent one from getting mixed up and entering a street address (which usually begins with a number) in the name area (field). It also prevents a leading space from fouling up the alphabetical sort. It does however leave the problem of blanking out the name altogether and this would assume that no record has no-name (all records must not have the name field blank).

The output part of the program can be very simple:

```
800 FOR X=1 TO 20
810 PRINT A$(X)
890 NEXT X
```

This however means that it will fill up the screen half way through so that some sort of screen handling routine is necessary to stop once the screen is filled and allow on pressing say enter to go to the next page and clear the old screen. The alternative is to just press CONT (continue) which not all users of the database may know to do.

Another problem is that this prints just a number at the end of the record. That is okay if you know that that number is a telephone number. Labelling it each time might go like this:

```
800 FOR X=1 TO 20
810 PRINT "NAME AND ADDRESS IS"
820 PRINT A$(X)(1 TO 20)
830 PRINT A$(X)(21 TO 50)
840 PRINT"TELEPHONE NUMBER IS"
850 PRINT A$(X)(51 TO 60)
890 NEXT X
```

For the sorting routines see the section on sorting routines in the programming booklet. Similarly search routines can be found there too. A good reference for these routines is the book, "The Essential Guide To Timex/Sinclair Home Computers" by Morse et al, Simon and Shuster Publishers, (1983).

To print out the data use a routine like one of the two above (without any pauses or "PRESS ENTER TO GO ON" routines at the end of each page) and just change all the PRINT commands to LPRINT commands.

Adding a simple menu module to goto the different options here such as:

```
100 CLS
120 PRINT "1-ENTER NEW DATA"
130 PRINT "2-LIST DATA ON SCREEN"
  .....
180 INPUT M$  'and 185 CLS
190 IF M$="1" THEN GOTO 700
200 IF M$="2" THEN GOTO 800
   ...............
```

... and so your program is written.

Anatomy of A Commercial Program

As an ordinary user, I can only program simple programs in BASIC while all the slick looking commercial programs are written in machine language (or compiled into machine language)? Not realy true! Other than compilers and interpreters (say for FORTH) and assemblers, most commercial programs are written in the built-in BASIC, just like the programs that you or I might write for the ZX-81/TS1000. They only seem to be machine language programs since they take special precautions to prevent us from breaking into them and stopping them so we can list the BASIC lines.

The common ZX-81/TS1000 programs, the database Vu-File (sometimes called The Organizer) and Vu-Calc, the spreadsheet, are written in BASIC. See, the book, "Vu-Calc and Vu-File, Getting Serious With Your Timex/Sinclair" by Robert B.V. Masters, 1984, Prentice-Hall Pub. Some commercial programs use machine language subroutines called from BASIC (by say a RAND USR), to speed up the graphics in a game or to speed up an alphabetical sort in a database, but most programs for the ZX-81/TS1000, commercial or not are written in the built-in interpreted BASIC, and the BASIC lines are their to view if you can break into the program somehow and LIST them.

Most commercial programmers deliberately went out of there way to make their programs unbreakable. Once you break into a program by stopping it running, you can usually figure out how to make pirate copies, and they did not want their handiwork copied freely by pirates. As a legitimate owner (of even a used program), you would be entitled to make a back-up copy or two. And this makes even more sense since a lot of (nearly all) the commercial Sinclair software houses have stopped supporting the ZX-81/TS1000, meaning if you ruin your one copy, you may not be able to get a good copy again anywhere, used, new, begged, borrowed or stolen. It is too bad that so many excellent programs were on the market for such a short period of time, at the height of the Sinclair fad, when over 1 million were made. It makes one sad to look at old magazines and newsletters and see all the programs that one might have wanted, now unorderable, years later, as the entrepreneurs or companies have gone on to other things and other makes of computers in at least some instances.

Breaking Into A Program To Make a Back-Up Copy

Even machine language programs usually have a few lines of BASIC in them, through which they were SAVEd and through which you can SAVE them again to make your legal back-up copy. Many tricks are used to conceal these lines and render part or all of them unlistable (without tricks). One is to put and extra enter character (code 118) in the middle of a REM statement, the part after this enter character, not being displayed and perhaps giving the impression that only the first half of the REM statement is the only line of BASIC in the program. If the first line is 1 REM, then you may wish to try not just LIST or LIST 1 but LIST 2, LIST 3, LIST 5 etc. until you see the hidden lines. There are many, many tricks. Poking the line number (see your users' manual, the first two bytes of a BASIC line give the line number, if the first line of the program starts at memory location 16509, POKE 16509,0 and POKE 16510,0 will make it line number 0 REM and you can't edit or modify it now - unless you POKE 16509,0 and POKE 16510, 1 to get it back as line number 1 REM), is another trick. There are variations on this too, for other statements than the first one in the program (see, "Mastering Your Timex/Sinclair 1000 Personal Computer by Hartnell and Jones, 1983, Bantam paperback), p.141-143. These books, though long out-of-print, still turn up in used paperback bookstores sometimes.

To keep you from breaking into a program, they will sometimes use the INPUT A$ command, even to input a number. If they used INPUT N, input a number, you can break in by inputing a long unlikely variable like WHATATHING then enter-newline. INPUT A$ etc. can be broken into by using the delete/backspace key to erase the left quotation and then enter STOP. If INKEY$ was used hitting the BREAK/SPACE key will stop the program.

Machine Language Programming For The TS1000/ZX-81

Yes, you can do machine language programming on the TS1000/ZX-81. But it is not a thing to triffle with as it takes about twenty times the time and effort to program the computer in machine language that it does in the built-in BASIC.

At the very minimum, what do you need? Well a book on Z-80 programming, a few tips about how to get the program in to the TS1000/ZX-81 so that the computer can process it and you can do a little experimentation with machine code right away. Note that I said Z-80 programming. The Z-80 is the microprocessor used in the TS1000/ZX-81 and it is the microprocessor that determines the instructions that you can use and how they will work for any home computer. So if you have a program for the Commodore 64 in machine language it will not run on the TS1000/ZX-81 since it is in the machine language of the 6510 (a 6502 family) microprocessor rather than the Z-80 and the instructions are totally different.

The TS1000/ZX-81 ROM is set up when you RUN a program, to look for a BASIC program in RAM, and start interpreting the contents of the RAM memory where the programs are placed, as BASIC program lines. You can however put a program in the memory so that the BASIC program interpreter is not upset or halted and yet fool the computer into processing it as a machine code program. What BASIC statement will not be processed but can be filled with any sort of content including machine code? Why the REM statement. So you can put your machine code inside a REM statement and the BASIC interpreter will pass right over it thinking it is just a comment, readable only by humans and not relevant to machines, like the computer.

To execute (run) machine code you must give the computer an address to start at. The best way to get this address is to put the machine code in the very first statement of the program and make it a REM ststament. Then we know that the first part of the remark area in the REM statement will be at memory location 16514. The command for the computer to start running machine code at a specific address is the USR command. The USR command (pronounced "user") has the peculiarity that it needs another command ahead of it. So you will use RAND USR or PRINT USR or LET X=USR.... Of course the USR is always followed by the address in memory (in base ten) where it is to start reading machine code.

How do you get the machine code in the REM statement? This may seem like a silly question until you actually try it. Machine code is straight numbers. Each character can only be entered as a character from the keyboard but what you are actually doing is entering a number code in that part of memory (RAM) that the computer LIST command translates into a character when it reads it. So to get the number 3C in hexadecimal which is the instruction in Z-80 machine language to INC (increment) the accumulator (register A) by one, you must enter the letter W, which has the base ten number value of 60 and the hexidecimal value of 3C. This is not too hard but many of the numbers that you must use in machine code are just about impossible to enter so that you must use special techniques such as POKE to get them in.

So if we are to run a simple machine code program we will call it by the command RAND USR 16514 which may be in your program as say the second or later line of your program (in BASIC). When a RAND USR instruction is encountered it will go to the address specified (here 16514) and interpret the numbers in memory at that point and on from there as a machine language program. Since there will be some random sort of contents there not intended to be read as machine code it will probably result in the computer crashing or locking up unless you put a readable, runnable machine code program there.

One more thing. Every machine code program will end in the Z-80 command to return the control to the BASIC program and execute the next BASIC instruction after the RAND USR. This is done by a return command like RET which is hex C9.

No we are ready to run a short test program in machine code. 00 is NOP no operation (which does nothing) in Z-80 code and C9 is RET or return. To enter this program in the first REM statement just put a space in (space's code is 00) and TAN which has the code C9.

Now run the program with a RAND USR 16514. It won't do anything in particular but this is the simplest machine code to run.

The Z-80 Microprocessor and Its Design Philosophy Speculated On

The first semiconductor central processing units used separate transistors and since they were expensive, the rule was that the fewer registers and the simpler the instructions, the cheaper and more competitive the computer could be. This became particularly crucial with the minicomputer, which in the 1960's tried to offer a smaller, cheaper version of a digital computer that could be used by scientists and engineering firms that could not afford a big, standard one.

Then, as integrated circuits combined many transistors and resistors etc. into one package, a miniaturized printed circuit board on a tiny chip of silicon it was realized that a group of such integrated circuits could be used (a chip set) rather than many, many transistors and full-sized printed circuit boards to make a central processing unit for a computer. The main part of the computer CPU was called the microprocessor and the first one was a 4-bit (register size) one called the 4004.

From the 4004 descended the 8008, an 8-bit version from which the first (often kit form) microcomputers were made. Then came an improved version the 8080 and from it the start-up company Zilog developed the Z-80 by adding more registers and many more features. But this was all evolved from the design philosophy of the single register (accumulator or register A) minicomputer when registers were expensive. Only gradually as it became apparent that registers could be added to a microprocessor without increasing the cost hardly at all, did the 8080 get more registers than the 8008 that preceded it and the Z-80 still later, even more registers. This shows up the key difference between the Z-80 and the IBM 360 or DEC PDP-11 which were designed from the start with multiple registers that you could perform any of the available arithmetic on no matter which register. The Z-80 is evolved from the single user-accessible register minicomputer which was designed to do all the arithmetic in one register, the accumulator. Thus with the Z-80 you can do all the 8-bit arithmetic with register A (the accumulator) but only certain of the operations with the other registers, B, C, D, E, and H and L (which are often intended to operate only as pairs with operations involving both not one), and even less with the alternate registers A', B', C' etc. (which for the ZX-81/TS1000 are really best left alone since the operating system uses some of them). In addition with the ZX-81/TS1000 and TS2068 as well there are eertain machine language instructions best not used (with TS2068 PUSH BC is rumoured to be one). These one will learn from experience but the amateur programmer will usually be trying to keep his programming simple in order to save on doing a lot of research into less commonly needed instructions intended for more complicated and fancy programming.

What other computers can use Z-80 assembly language programs for the ZX-81? Well, since the operating system (software) and the layout of RAM and peripherals varies with different computers, you may very well not be able to swap Z-80 assembly language programs with other computers without modifying them to suit their new environment, which is a different system surrounding the microprocessor.

What other microprocessors are compatible with the Z-80 assembly language? Now as far as I know, only the Z-280 and Hitachi/NEC version, 64180 are. Machine code for the 8008 will run on the 8080, Z-80, 8085 and 8088 microprocessors. Machine code for the 8080 can be run on the V-20* but not directly on the 8088. Machine code for the 8080 can be run on the 8085 and Z-80. Why aren't the assembly languages interchangable when the machine languages are? Simply because different mneumonics are used in the Z-80 compared to the 8080 on the one hand and the 8088 of IBM PC fame on the other. The codes of the 6502 (Apple II), 6510 (Commodore 64), 6809 (Radio Shack Coco) are of course completely incompatible as with the 68000 (Macintosh, ST, Amiga).

So you may find machine code easier to understand and use if you can relate it to the history of the microprocessor, and its family tree.

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*A planned V-25 was to be Z-80 compatible, but never seen. The V-20 uses BRKEM, 0FFF cc, (where cc is like 8088 INT cc)to call 8080 emulation mode & RETEM ED FD to go back to 8088 mode.

Other Languages On The ZX-81/TS1000

As mentioned elsewhere, a number of other languages are available to run on the ZX-81/TS1000 including a couple of FORTH dialects, compiler and interpreters, integer BASICs like MCODER, which cannot simply compile an ordinary ZX-81 BASIC program, but whcih must have there programs written separately due to incompatibilty of BASIC dialects, largely in the way of lack of support for many features of the built-in, ZX-81 BASIC, at least one Pascal, a non-standard subset with integer (but fixed point decimal constants) only supported as to variables and number print-out, plus some interpreters like Tiny C and LOGO. But as to the question of whether any of these are sensibly, practical alternatives to programming in the built-in ZX-81/TS1000 BASIC interpreted language, well..., the writer has never known anyone to use any of these on the ZX-81/TS1000 for other than playing around with (by way of experiment that is). Assembly language/machine language for some professional programmers yes. But for the hobbyist, machine language is mainly used for a couple of dozen bytes to speed up a BASIC program in spots where the built-in BASIC's slowness makes that necessary, such as certain screen movements in a video game. But it need not necessarily be that these often excellent higher level languages need be neglected, by the serious programmer.

Some people look back with wonder at the early days of home computers when the BASIC dialects were integer BASICs, and they made screen graphics quicksilver fast. If only perhaps we could get our hands on one of those older computers like the ZX-80, predecessor of the ZX-81! But with an integer BASIC like the MCODER compiler, you can use this, if you are ready to learn a whole new dialect, and just use programs written in it for certain things like games, where you need not print any fractional figures, the advantage of floating point BASIC's with their lower machinations. Character handling routines might under some circumstances work and games with graphic displays, provided you don't try to use a big game, and a 16K RAM pack only, since MCODER II takes up 8K of the 16K itself, and it must be in the computer RAM in its entirety, at all times, to make the program run (a separable run-time module is not part of it, the compiler must be resident to run the programs, it containing the necessary run-time module).

A number of aftermarket suppliers did at one time provide extensions for the built-in BASIC, using certain tricks to get it to accept READ, DATA, etc. commands popular in other BASIC' (and the TS2068). Of course you can get BASIC programs to run almost any command, although slowly and with limited program size as in the writer's crude attempts to get COBOL arithmetic statements and FORTRAN DO loops to be interpreted and run within a ZX-81/TS1000 BASIC program, not to mention a PDP-11 assembly language trainer sort of development system. But beyond the novelty and the fun with doing it yourself, practical limitations of speed and memory and willingness to do the work necessary to get them running nicely, (the PDP-11 program has been in development for 5 years at least by now), we are in the category of toys or educational items, not real stuff.

That leaves FORTH. Once even seriously used for control programs, like using a computer to control an astronomical telescope, and for systems programming, such as computer ROMS and operating system routines and modules, FORTH is a language that has been little used of late, although it has its fans, C language has largely replaced it for systems and control programming. The dialects of FORTH available on home computers of the earlier types certainly are superior and cheaper to some of the C language programs in some cases and certainly a lot easier to find used and public domain for home computers. While ther is a lot of C language expertise, books, magazine articles and source code of routines around, there is practically no such easy source for FORTH language learning/mastery by the average hobbyist. Unfortunate, and FORTH probably still has a great, untapped potential, but there you are. Theoretically useful, but not to practical. The Artic FORTH that the writer has tried also tends to crash easily and has other features that make it baulky, such as a screen save that doesn't work well with cassette recorders, and often the remedy of taping a little hissing background noise before a screen save (that is how source code is saved, by the screen), will grab the automatic volume circuits of your cassette recorder on playback, so that it won't lose the first part of the screen, (and crash as a result).

So many of these higher level languages have in common with the machine code programs of any type, the habit of crashing the computer so often, that you had better use them with a disk drive, or reloading them after the 5th crash will destroy your patience with most of these otherwise interesting compilers.

Bibliography ZX-81/TS1000

The Users Manual -which may come with a used ZX-81/TS1000 or may have become separated from it someway, is very well written and as close to essential as can be for any of these books.

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There are lots of books specific to the ZX-81/TS1000 that can be very useful, but are long out-of-print, and since you won't be able to buy them if you don't come accross them, are probably not worth mentioning here. Just make sure that they are for the ZX-81 or TS1000 or even TS1500 and NOT for other Sinclair computers like the TS2068, Spectrum, TS2000, Spectrum Plus, Spectrum 3, Amstrad, Z-88 and even the ZX-81's predecessor, the ZX-80. These are not for the same computer and their contents will be of no or little use in learning how to use the quite different ZX-81/TS1000. Also bypass BBC Micro, BBC BASIC, etc. books, again for the same reason. But buy any ZX-81/TS1000 specifics you see, especially if they are cheap. Most will help you understand the machine better and only a few will turn out to be a waste of money for the ZX-81/TS1000 user.

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Single most useful out-of-print paperback book:- (a Bantam Paperback,1983)

Mastering Your Timex Sinclair 1000 Personal Computer,
by Tim Hartnell and Dilwyn Jones

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Sinclair ZX-81 ROM disassembly, (the ROM of the ZX-81 is assembly language):

This standard work for the expert machine language programmer, hacker, comes in several versions, a one and a two volume version, all by Dr. Ian Logan, the one the writer has seen:

Sinclair ZX-81 ROM Disassembly, Part A and Part B (2 vols.)
by Dr. Ian Logan

To give you the flavour, it starts at memory location zero with:-

```
0000 START OUT (+FD),A
           LD BC,+7FFF
           JP 03CB,RAM-CHECK
```

and on an on with little commentary for 30 pages per volume which will seem cryptic at first but after a lot of head scratching like days or weeks, may start to make sense to an assembly language programmer. Don't expect to be able to pick it up and read it like a popularization of Einstein's discovery of relativity, anyway. But the first time anything is hard.

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The machine language/assembly language programmer's bedside companion for the Z-80 microprocessor which is used in the ZX-81/TS1000 is probably:-

Rodnay Zaks, Programming The Z-80 (publisher Sybex, original edition 1979, several revisions)

It is a heavy duty book but full of useful information. It does not mention the ZX-81 or anything ZX-81 specific, just the facts on the Z-80 microprocessor and how to built computer programs from its assembly language (or machine language) instructions.

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A couple more classics: The Essential Guide To Timex/Sinclair Home Computers
by Morse,Adamson,Anrep,Hancock (Simon & Shuster,'83)
-excellent BASIC routines, ready to run,sort,search.
Machine Code and better BASIC by Stewart & Jones
-explains stacks,queues,linked lists & works in some ZX-81 machine code programming examples

Publications Of The Writer Of This Book/Booklet

That May Also Be Of Interest

The writer has published various newsletters over the last few years of which some back issues may be available for a small sum plus postage, (figure on $2 to mail one, more if a fresh copy need by made if it is out of stock). Subscriptions usually not available.

These Include:

TS Bulletin series of newsletters of various titles, dealing with Timex-Sinclair computers, especially the ZX-81/TS2068 and amateur computer use in general. (1987-1991)

Home Computer Orphan Survival Newsletter - for non-Timex/Sinclair Users, similar to above TS Bulletin.(Up to 1990)

Northern Hobby Computer Users' Newsletter (Northern-Northern USA, and Canada in general) - which deals with issues of interest to the hobby programmer owning an MS DOS, Apple, Amiga, Atari ST, NeXT, or CP/M home computer and interested in pondering its technical aspects, amateur programming and computer trends and predictions. (1990-?)

Books/Booklets(Paper) ...... (If unbound, approximate) (cost about 20¢ per page)

Unofficial ZX-81/TS1000 Larken Disk System Technical Manual (in preparation, but draft copies available for review) - approximately 120pp.

Tips, Tricks and Techniques From The User Group Masters For The ZX-81/TS1000 (in preparation, but draft copies available for review) -approx.40pp.

Generic DOS Manual -Early Version, General Disk System Booklet Material

Famous Computers, from series of newsletter articles of the same name,

Assembly Language Programming:Tips and Philosophy (For the ZX-81/TS1000)

Generic Orphan Computer User's Manual - in preparation (version français aussi à paru)

....

On disk only,(320K, MS DOS, 5¼" floppy, ASCII, EDLIN output compatible)

Generic DOS Manual - Miscellaneous Material for Writing One, Text Ready to 'clip' and go into your own version, general explanations, disk concepts, samples of particluars for some disk systems like MS DOS, CP/M, UNIX etc.

MS DOS - DOS Help.DOC -Help in getting started with MS DOS/PC DOS, a good file to keep on your system or hard disk, for the beginner.

articles on Pascal, CP/M, CBASIC (CP/M compiler), Operating System Philosophy, glossaries of technical terms, etc. -available for user groups

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Almost Famous Programs

- PDP-11 Trainer (in Assembly Language Programming, PDP-11 instructions, a small sub-set of), for Timex-Sinclair ZX-81/TS1000 (written in BASIC)
- Foreign Language Text Edit/Creators -(GW BASIC)for IBM PC, MS DOS, French e.g.

Identifying Other Related Computers

Cambridge Z-88

A design of Sir Clive Sinclair after he sold his company and name to Amstrad, this is not compatible at all with other Sinclair computers, using the very different BBC BASIC, which is not descended from Sinclair BASICs. It does however use the Z-80 microprocessor.

The Spectrum

Produced in a large number of different versions from 16K to 128K over the years, the Spectrum is the big brother to the ZX-81/TS1000 in Britain. A few exist that were converted to function with US/Canadian television systems (versus the British PAL) and 117 vs. 220 volt psu's. Many more TS2068's have been converted to run on the ROM of the Spectrum so that they can run Spectrum programs available cheaply and in great variety from Britain. The Spectrum cassettes are not compatible with ZX-81/TS1000 cassettes (they record at a different baud rate) nor will most Spectrum programs run without changes on the ZX-81/TS1000 since the Spectrum BASIC has extra commands that the ZX-81/TS1000 lacks. ZX-81/TS1000 programs in BASIC (with no machine language, ROM calls or peeks and pokes) will often run on the Spectrum (with perhaps only a few changes made to the program) if keyed in from a listing. ZX-Printer and other Timex-specific printers that run on the Spectrum probably will also run on the ZX-81/TS1000. The Larken disk drive system requires a different ROM version to run on the Spectrum machine than the ZX-81/TS1000 and that goes for most disk drive systems (although many are not even Spectrum compatible and will run only in TS2068 mode). The Spectrum does however use the same microprocessors of the Z-80 family (varying only in speed) as the ZX-81/TS1000 making the transfer of machine language programs between the two easier although because of their different architectures not 100% compatible in every case.

The TS2068

This computer was produced only for the foreign market by Timex and Sinclair. It is found in the U.S.A., Canada, Portugal and perhaps places like Brazil (in clone form). It is not strictly compatible with the Spectrum but all the things said about compatibility between the Spectrum and ZX-81/TS1000 apply also to the relationship between the TS2068 and the ZX-81/TS1000. See above for that.

The QL

The QL uses an entirely different microprocessor than the other Sinclair designs, the 68008, making machine language and architecture totally different. Its cassettes are not compatible with the other computers at all. However programs written for the other computers may be transferable to the QL if written in BASIC and having no peeks, pokes, ROM calls or machine language and if they are keyed in from a listing into the QL BASIC(i.e.SuperBASIC). None of the QL accessories are interchangeable with the other computers as far as the writer knows. A clone called the THOR, has been sold in Denmark.

The TS1500

This computer a progressive development of the ZX-81/TS1000 with a new ROM, better keyboard and built-in 16K of memory (versus the need for a RAM pack to expand to 16K in the ZX-81/TS1000)& is more or less compatible with the ZX-81/TS1000 although some ROM changes made. BASIC programs as well as other commercial programs for the ZX-81/TS1000 will also run on the TS1500. On the other hand special programs have been written that will only run on the TS1500 (or special versions of programs also available in ZX-81/TS1000 versions). It is said that one can change the ROM in the TS1500 by unplugging the old one and plugging in a ZX-81/TS1000 ROM if you want complete compat-

Other Computers -Identifying (Continued)

ibility with the ZX-81/TS1000. These ROMS are available from Sinclair suppliers or may be taken out of an old ZX-81/TS1000.

TS2000 - See Spectrum

Spectrum Plus, Spectrum 3, Spectrum 128 - Later versions of Spectrum. See above.

The PC8300 (An Oriental Clone of the ZX-81/TS1000)alias IQ8300,alias Power3000

This computer being dumped on the surplus market currently (1987-8) offers a cheap entree to ZX-81/TS1000 computing. It is basically a ZX-81/TS1000 with a ROM that has been changed around enough to try to avoid charges that it was simply a copy of the (copyrighted) ZX-81 ROM. The character code is also different. For that reason many programs that will run on the ZX-81/TS1000 will not run on the PC8300 although most will. Its microprocessor is a Z-80A running at the same clock speed as that in the ZX-81/TS1000 so that machine language routines may be transferred to it if one takes into account the differences in the architecture especially the ROM. Accessories for the PC8300 include a 16K and 32K memory expansion and a Colour **Pack** expansion. Apparently the ZX-81/TS1000 RAM pack will work with it. The computer has a sound feature and built-in speaker as well as a TS1500/TS2068 style keyboard (with moveable keys in other words) but still with the membrane switches underneath.

The most important thing to remember with the PC8300 is never, NEVER to use a TS2068 power supply with it. The connector will fit but the PC8300 will be damaged beyond repair since the polarities are reversed. This suggests a preventive measure —installing a 1 amp. Schottky diode inside the PC8300 to prevent such polarity reversals from damaging the computer.

The most frequent problem with the PC8300 seems to be with bad cassette saves (noisy tapes). The solution seems to be to use a true 12 volt power supply with it rather than a modified ZX-81/TS1000, 9 volt one. Rumour has it that this solves the problem.

Recently it has been learned that : Fred Nachbaur of Silicon Mountain Computers, C-12, Mtn. Stn. Group Box, Nelson, B.C. Canada V1L 5P1 has made a modified ROM for the PC8300 which would make it more compatible to the ZX-81/TS1000 as far as programming is concerned,alto Fred has ceased business.

Jupiter Ace 4000

A ZX-81 style computer with Z-80A at 3.25 MHz, it has in ROM FORTH 79 integer FORTH. It can be used as a programmable controller, has moveable keys (40) including caps lock and autorepeat, high speed cassette interface, same graphics as ZX-81 (32 col.) & RAM expands to 51K. (source- Radio-Electronics, Jan. 84)

TS2048

A physically smaller version of the TS2068 but Spectrum compatible, this computer was manufactured and sold in Europe. U.S. versions possible. It is seen in Portugal and Brazil mainly. Timex OS for disks also seen there.

Sinclair ZX-80 and Micro Ace

The ZX-80, a forerunner of the ZX-81 and the Micro Ace (a clone?!) will on the whole run neither machine language or BASIC programs for the ZX-81/TS1000 unless their original 4K ROM has been replaced by the 8K ZX-81 ROM. (Kits and instructions for doing this were sold when the ZX-81 came out). The ZX-80 and Micro Ace BASIC is an integer BASIC (no decimal fractions).
(source- Sync magazine)

Futura, FORTH Machine

At one time, Futura produced a sort of clone of the ZX-81/TS1000 which had a FORTH interpreter in the ROM rather than BASIC. It is not known if any were actually sold although a prototype was shown at a computer fair a number of years ago and is mentioned in the defunct Sinclair computer magazine Sync. At any rate such a machine would not appear to be compatible with the ZX-81/TS1000 as far as programs are concerned. Hardware might be. (See also Jupiter Ace 4000, above).

Disk Drive Systems for the ZX-81/TS1000

It is not generally known, but several suppliers that carry disk drive systems for the TS2068 also carry them for the ZX-81/TS1000. The one that the author has used and can therefore vouch for was produced by Larken Electronics, R.R.#2, Navan, Ontario, Canada K4B 1H9. It will save a 16K BASIC program that would normally take 6 minutes by cassette in about 10 seconds! It will save 160K on a 5¼ inch DSDD diskette and saves only the length of the program (rather than in some systems the whole memory), thus reducing the amount of disk space used up. So in this round-up of hardware information for the ZX-81/TS1000 it would be wise to mention both a book of tips from Syncware News newsletter and the booklet produced by this publisher on the Larken Disk System, "The Master Guide to the Larken Disk System (ZX-81/TS1000)." Both books will help with other hardware and (software) problems with the ZX-81/TS1000. See below on ordering the disk book.

Unofficial Manual For The Aerco Disk System For The ZX-81/TS1000 (1991)

In preparation by **Mr Donald Lambert**,1301 Kiblinger Pl.,Auburn,IN,USA 46706.

Review: A while ago the writer obtained a book of short programs, articles and tips both hardware and software, for the users of the ZX-81/TS1000 personal computers. It consists of a completely retypeset reprint in a larger and easier to read format paperbound book of the issues from June 1983 to June 1984 of the magazine "SyncWare News" which at that time concerned itself exclusively with the ZX-81/TS1000. The book includes a series of hardware projects including plans for various kinds of power back-ups using batteries (momentary loss of power due to line surges is a common cause of crashes when running BASIC programs on the ZX-81). It also includes articles on fixes for various hardware and software problems and programming tricks. In addition, a series of articles on using the ZX-81 for mathematical work including calculus, simultaneous equations, and statistical methods makes up a large series of articles in the book. Itwas available from SyncWare News, a now defunct magazine and newsletter for the TS2068/ZX-81 hobby user.

The Unofficial - Guide to the Larken Disk Drive for the ZX-81/TS1000

The publishers of this booklet also are publishing a booklet called the "Master Guide to the Larken Disk System (ZX-81/TS1000)". This book takes the user from the simplest use of the system in loading and saving BASIC programs through to more advanced topics on how the system works internally and various programs of use to the user of the disk system.

It shows program modules to make your programs self-starting (coming up on the screen running as soon as loading form disk is complete) and tries to explain the basics of use and care of diskettes and other hardware and software topics of interest to the user of this disk system.

The Larken system is fast, efficient and available at a low cost. In addition systems are also available from Larken Electronics for the TS2068 and it is believed a system that can be switched between use with the TS2068 and the ZX-81/TS1000 so that you need not buy two separate systems.

In short this book is a supplement to the manual supplied with the systems as well as an explanation of the material that is in it that takes one from what to do after you take the system out of the box on getting it through the mail through to more advanced theory and use of disk systems. It is the one indispensable book of its kind for the Larken ZX-81/TS1000 user and is available from the publisher of this booklet for about $46. This book is available in early, draft form to selected friends, and runs to about 125 pages, (for review, help in checking only).

Long Island Timex Group -ZX-81/TS1000 Tips Booklet

In the fall of 1990, this user group was selling this booklet. Address: LIST, 5 Peri Lane, Valley Straem, NY, USA 11581.